Armstrong World Inds. PR 96082
Boiler

APPLIED SCIENCE AND TECHNOLOGY DIVISION

Source Testing & Engineering Branch

ROUTING RECORD

DATE	FROM	TO	ACTION
11-7-96	MM	SM	ASSIGN
11/13/96	SM	HSC	Evaluate
11/19/96	HSC	SM	Review
11/26/96	SM	MM	Log Out
6-4-13	GL		Scanned

REFERENCE TO OTHER RECORDS INCLUDING VARIANCES

R

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
APPLIED SCIENCE and TECHNOLOGY * SOURCE TESTING and ENGINEERING BRANCH

PERFORMANCE TEST DATABASE

STID: P R 96082 **APPL#:** **COID:** 012155

COMPANY: Armstrong World Industries
BASIC EQUIPMENT: Boiler
CONTROL EQUIPMENT:

PERMIT NUMBER:
RULES / PERMITS: Rules 2012, ~~1146~~
EMISSION LIMITS:
POLLUTANTS:

CO	NOx, NO/NO2			

AST ASSIGNED: Choe
ENG. CONTACT: Desh Jain **UNIT:** 2555

ENGINEERING FIRM:
TEST FIRM: Carnot
TEST FIRM CONTACT: Bruce Fangmeier **PHONE:** (714) 259-9520

PROTOCOL STATUS: Conditionally Acceptable
REPORT STATUS: Pending Report Evaluation

	PROTOCOL	REPORT
EVALUATION HOURS		5
ARTICLE DATE		05-Nov-96
TESTED		26-Sep-96
RECEIVED	21-Jun-96	05-Nov-96
REQUESTED	21-Jun-96	
RESPONDED	10-Jul-96	
APPROVED	10-Jul-96	
ISSUED	11-Jul-96	
CANCELLED		

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

M E M O R A N D U M

DATE: November 19, 1996

TO: Merrill Hickman

FROM: John Higuchi JM for JH

SUBJECT: Evaluation of Source Test Report:
(Requested by Merrill Hickman, November 5, 1996)

IDENTIFICATION: **(Facility ID No. 012155)**
COMPANY: **Armstrong World Industries, South Gate**
EQUIPMENT: **Boiler (D156)**

REFERENCE: **PR 96082** (ASTD Source Test File)

Source Testing & Engineering has evaluated the subject source test report dated October, 1996, for the equipment located in South Gate.

The test report for concentration limit is "acceptable," meaning that the testing and analytical methods meet District approved standards, the test conditions are indicative of the process under normal or stipulated conditions, and the reported source test results accurately reflect these qualifications.

However, the relative accuracy audit (RAA) showed that the relative accuracy of the flow meter was poor. An alternative relative accuracy audit is recommended. The attached evaluation clarifies the remediation requirements for the RAA.

If there are any questions, please contact Hui Sung Choe at Ext. 2259.

ARC:HSC

Attachment

armstrep.doc : REV 9/5/96

GENERAL INFORMATION

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

APPLIED SCIENCE & TECHNOLOGY DIVISION * SOURCE TESTING & ENGINEERING

APPLICATION / REPORT / REPORT REVIEW

DATE: November 19, 1996 *EVALUATOR:* H. Choe *EXT:* 2259

S/T ID: **PR 96082**

COMPANY: **Armstrong World Industries**

IDENTIFICATION: **(Facility ID No. 012155)**

EQUIPMENT: **Boiler (D156)**

LOCATION: **South Gate**

TEST FIRM: **Carnot**

EVALUATE: **NO_x at 3% O_2 and RAA per Rule 2012**

TYPE EVAL:

☐ CEMS APPL ☐ CEMS PROT ☐ CEMS RPRT ☐ PERF PROT ☐ PERF RPRT ☐ OTHER: ________

RECLAIM Specific Requirements (☐ MAJ ☐ LGE ☐ PRC):

☐ CEMS PLAN ☐ 6/12 MO RECERT ☐ ALT EMIS FACT ☒ 3-YR (RE)CERT ☐ ACEMS ☐ OTHER: ________

1. SPECIFIC REQUIREMENTS:

☒ The document indicated above has been reviewed by the Evaluations Unit staff and has been determined to contain sufficient information, as presented.

☐ The document indicated above has been reviewed by the Evaluations Unit staff and has been determined to contain insufficient information, or requires further explanation, in the following area(s) (see complete attached discussion):

- ☐ Equipment/Process Description
- ☐ Completeness of Application/Report/Report.
- ☐ Representativeness of Data & Process.
- ☐ Rule/Permit Fulfillment.
- ☐ Sampling & Analytical Methods.
- ☐ Quality Assurance
- ☐ Calculations

2. COMMENTS:

OVERVIEW

Armstrong World Industries source tested the boiler (D156) for NO_x concentration limit and fuel meter relative accuracy compliance per Rule 2012.

REPRESENTATIVENESS OF DATA & PROCESS

The fuel meter relative accuracy was found to be - 43%, meaning that the calculated stack flow rate (dscfm) was 43% lower than the actual measured stack flow rate (dscfm). Due to the high discrepancy in the flow rates, the relative accuracy of the fuel meter is questionable.

Also, the flow velocity in the stack was very low (< 0.05 in. H_2O). The three run RAA did not show consistent velocity profiles from one run to another. Because of the extremely low velocity in the stack and the poor relative accuracy obtained, an alternative RAA is recommended to verify the fuel meter relative accuracy.

3. REMEDIATION:

An alternative RAA should be conducted to verify the fuel meter accuracy. An alternative RAA must be proposed by the facility for review and approval.

PR96082

CARNOT

October 7, 1996
AWI1J-11523
R120G300.T

Mr. Merrill Hickman
Air Quality Engineer II
South Coast Air Quality Management District
21865 East Copley Drive
Diamond Bar, CA 91765-4182

Subject: **RECLAIM Large Source Compliance Testing at Armstrong World Industries, Inc. (SCAQMD Facility I.D. No. 012155)**

Dear Merrill:

Enclosed please find one (1) copy of the document titled **"Test Report for SCAQMD Rule 2012 (RECLAIM) Large Source Compliance Testing at Armstrong World Industries, Inc."** This report documents the results of the RECLAIM Large Source compliance testing that Carnot conducted on the process steam boiler (SCAQMD Device I.D. D156) at Armstrong's South Gate manufacturing facility on September 26, 1996.

As you may recall, Carnot prepared a unit-specific test protocol for testing this boiler which was submitted to the SCAQMD on June 13, 1996; the protocol was granted conditional approval by the SCAQMD on July 19, 1996. However, on July 18 the SCAQMD issued a standard test protocol for boilers classified as Large Sources under RECLAIM and subject to a concentration limit (SCAQMD Standard Protocol SP-B-001), which greatly simplified the source testing requirements for such sources. As a consequence, a decision was made by Armstrong and Carnot to use this standard protocol to conduct the testing of this boiler. All testing was conducted per the standard protocol, and a Certification of No Exceptions to Standard Protocol was signed by Mr. William Woyshner of Armstrong World Industries, Inc. and is included in Appendix B.5 of the report.

If additional copies of this report are needed or if you have further questions, please contact me at (714) 259-9520; my fax number is (714) 259-0372.

Sincerely,

CARNOT

Bruce A. Fangmeier
Senior Engineer

BAF/wp

cc: Bill Woyshner, Armstrong World Industries, Inc.

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 · FAX (714) 259-0372

TEST REPORT FOR SCAQMD RULE 2012
(RECLAIM) LARGE SOURCE
COMPLIANCE TESTING AT
ARMSTRONG WORLD INDUSTRIES, INC.
(SCAQMD FACILITY I.D. NO. 012155)

Prepared For:

ARMSTRONG WORLD INDUSTRIES, INC.
South Gate, California

For Submittal To:

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
Diamond Bar, California

Prepared By:

Bruce A. Fangmeier

CARNOT
Tustin, California

OCTOBER 1996

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and documented in this report were carried out under my direction and supervision.

Date 10/7/96

Bruce A. Fangmeier
Senior Engineer
So. Calif. Measurement Division

I have reviewed, technically and editorially, details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Date 10/7/96

Robert A. Finken
Vice President
So. Calif. Measurement Division

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SECTION 1.0

INTRODUCTION

1.1 PROGRAM OVERVIEW

Carnot was contracted by Armstrong World Industries, Inc. (AWI) to provide measurement services for their floor tile manufacturing facility located at 5037 Patata Street in South Gate, California (SCAQMD Facility I.D. No. 012155). Carnot conducted emission measurements on the facility's process steam boiler (SCAQMD Device I.D. D156) to demonstrate compliance with the concentration limit for this boiler under SCAQMD Rule 2012 (RECLAIM), as well as to determine the relative accuracy of the boiler's totalizing fuel meter.

AWI operates a single boiler used to produce process steam for their South Gate facility which is classified as a Large Source under SCAQMD Rule 2012 (RECLAIM). The boiler is used to produce steam used in various process units at the floor tile manufacturing facility. The boiler is served by a single totalizing fuel meter which was installed specifically to comply with the requirements of SCAQMD Rule 2012. The boiler has a RECLAIM concentration limit of 30 ppmv NO_x at 3% O_2.

The RECLAIM Large Source compliance testing for the process steam boiler at AWI's South Gate manufacturing facility was conducted on September 26, 1996. Testing was coordinated by Bill Woyshner of AWI and Bruce Fangmeier of Carnot. The Carnot test team consisted of Bruce Fangmeier and Rick Madrigal.

1.2 TEST PROTOCOL

Carnot prepared a unit-specific test protocol for testing this boiler which was submitted to the SCAQMD on June 13, 1996. Conditional approval for the unit-specific test protocol was issued on July 19, 1996. On July 18, however, the SCAQMD issued a standard test protocol for boilers classified as Large Sources under RECLAIM and subject to a concentration limit (SCAQMD Standard Protocol SP-B-001), which greatly simplified the source testing requirements for such sources. As a consequence, a decision was made by AWI and Carnot to use this standard protocol to conduct the testing of this boiler. All testing was conducted per the standard protocol, and a Certification of No Exceptions to Standard Protocol was signed by Mr. Woyshner of AWI and is included in Appendix B.5.

1.3 SUMMARY OF RESULTS

Table 1-1 summarizes the final results of the RECLAIM Large Source compliance testing and fuel meter relative accuracy audit for the process steam boiler at AWI's South Gate facility.

TABLE 1-1
RESULTS SUMMARY
RECLAIM LARGE SOURCE COMPLIANCE TESTING
PROCESS STEAM BOILER
ARMSTRONG WORLD INDUSTRIES, INC.
SOUTH GATE PLANT
SEPTEMBER 26, 1996

CONCENTRATION LIMIT COMPLIANCE:	
Measured NO_x Emissions:	28.19 ppmv NO_x at 3% O_2
FUEL METER RELATIVE ACCURACY AUDIT:	
Relative Accuracy:	-43.3%

1.4 REPORT ORGANIZATION

Section 2.0 of this report describes AWI's process steam boiler and the normal operational mode of the boiler, and also includes a description of the boiler's totalizing fuel meter. Section 3.0 describes the test procedures used during the RECLAIM Large Source compliance testing on the boiler. Section 4.0 presents detailed results of the compliance testing, including RECLAIM concentration limit compliance and fuel meter relative accuracy. The appendices to the report completely detail the RECLAIM Large Source compliance testing on the boiler.

SECTION 2.0

UNIT DESCRIPTION

The process steam boiler at AWI's South Gate manufacturing facility is a Tampella Keeler Model No. CP 200 hp water-tube boiler equipped with a Keeler Dorr Model WB-1-13-FGR gas burner, incorporating flue gas recirculation (FGR) for low NO_x operation. The boiler has a maximum rated heat input of 14.07 MMBtu/hr and maximum steam production of 9,000 lb/hr at approximately 125 psig. The boiler's RECLAIM concentration limit is 30 ppmv NO_x at 3% O_2.

The boiler is equipped with a totalizing fuel meter which was installed by Measurement Control Systems, Inc. specifically to comply with the requirements of SCAQMD Rule 2012. The totalizing fuel meter is an American Meter Company Model 3GT-10M axial flow turbine meter.

It should be noted that this boiler's steam production capacity is significantly larger than the actual steam needs of AWI's manufacturing facility. It normally operates with a heat input of approximately 6.5 MMBtu/hr, producing approximately 6,000 lb/hr of steam. To compensate for this oversized boiler, and to reduce the amount of natural gas burned in the boiler, AWI installed an Allen-Bradley boiler control system to control main burner operation as follows:

1. The boiler igniter, used to ignite the natural gas flowing out of the main burner, is lit at all times.

2. The pressure in the main steam drum is used to control the on/off sequence of gas flow to the main burner, with a lower pressure setpoint of 118 psig and an upper pressure setpoint of 125 psig.

3. As steam is sent to the manufacturing facility, the pressure in the main steam drum slowly drops until it reaches the lower setpoint of 118 psig. At that time the natural gas supply valves leading to the main burner open, and the natural gas flowing out of the main burner is lit by the boiler igniter. The firing of the main burner continues until the pressure in the main steam drum reaches the upper setpoint of 125 psig, at which time the gas supply valves to the main burner shut, extinguishing the main burner.

4. This on/off sequence is repeated several times throughout each hour of boiler operation, with the main burner firing for approximately four minutes and then shutting off for approximately four minutes.

5. The flue gas recirculation (FGR) control valves, which allow flue gas to be drawn from the boiler exit and into the burner windbox, are controlled by the temperature of the flue gas at the boiler exit. When this temperature reaches a setpoint of approximately 325 degrees, the valves open and start the recirculation of flue gas. This setpoint is only reached when the main burner is actually firing.

As described in Section 3.1, the operation of the boiler was adjusted during the RECLAIM Large Source compliance testing in order to obtain a testable boiler operating condition.

SECTION 3.0

TEST DESCRIPTION

This section outlines the procedures which were followed for the RECLAIM Large Source compliance testing program on the process steam boiler at AWI's South Gate facility. Included in the following sections are discussions of boiler operation during testing, and a description of the sample location and reference method test procedures.

3.1 UNIT OPERATION

In accordance with Section 4.1 of SCAQMD Standard Protocol SP-B-001, the RECLAIM Large Source compliance testing and fuel meter relative accuracy audit on the process steam boiler at AWI was conducted at a single boiler load, approximately equal to 6.5 MMBtu/hr of heat input and producing approximately 6,000 lb/hr of steam. As was noted in Section 2.0, the boiler's steam production capacity is significantly larger than the actual steam needs of AWI's manufacturing facility, and the Allen-Bradley control system of the boiler cycles the main burner on and off. As it was not possible to achieve meaningful test results with the boiler cycling in this manner, a valve on the vent line leading from the main steam drum to the atmosphere was opened to vent a portion of the generated steam to the atmosphere and forcing the boiler to begin firing the main burner constantly. Appendix D.2 includes a copy of the circle chart produced by the boiler's recorder showing the shift from cyclic to constant firing of the main burner.

3.2 SAMPLE LOCATIONS

Figure 3-1 includes plan and side views of the exhaust duct configuration leading from the boiler to the concrete stack. As can be seen in this figure, the exhaust duct includes bends, contractions and expansions over its length. Since the concrete stack does not have access for reference method sampling, four sample ports are installed in a straight run of rectangular duct inside the boiler house.

Figure 3-2 provides the detailed layout of the sample ports which were used for this test program. The sample ports are installed in a section of rectangular duct 7 ft 6 in long and 30" deep by 44.5" high. The sample ports are located 71-3/8" (2.0 diameters) downstream of a duct bend and 17-5/8" (0.5 diameters) from a duct constriction.

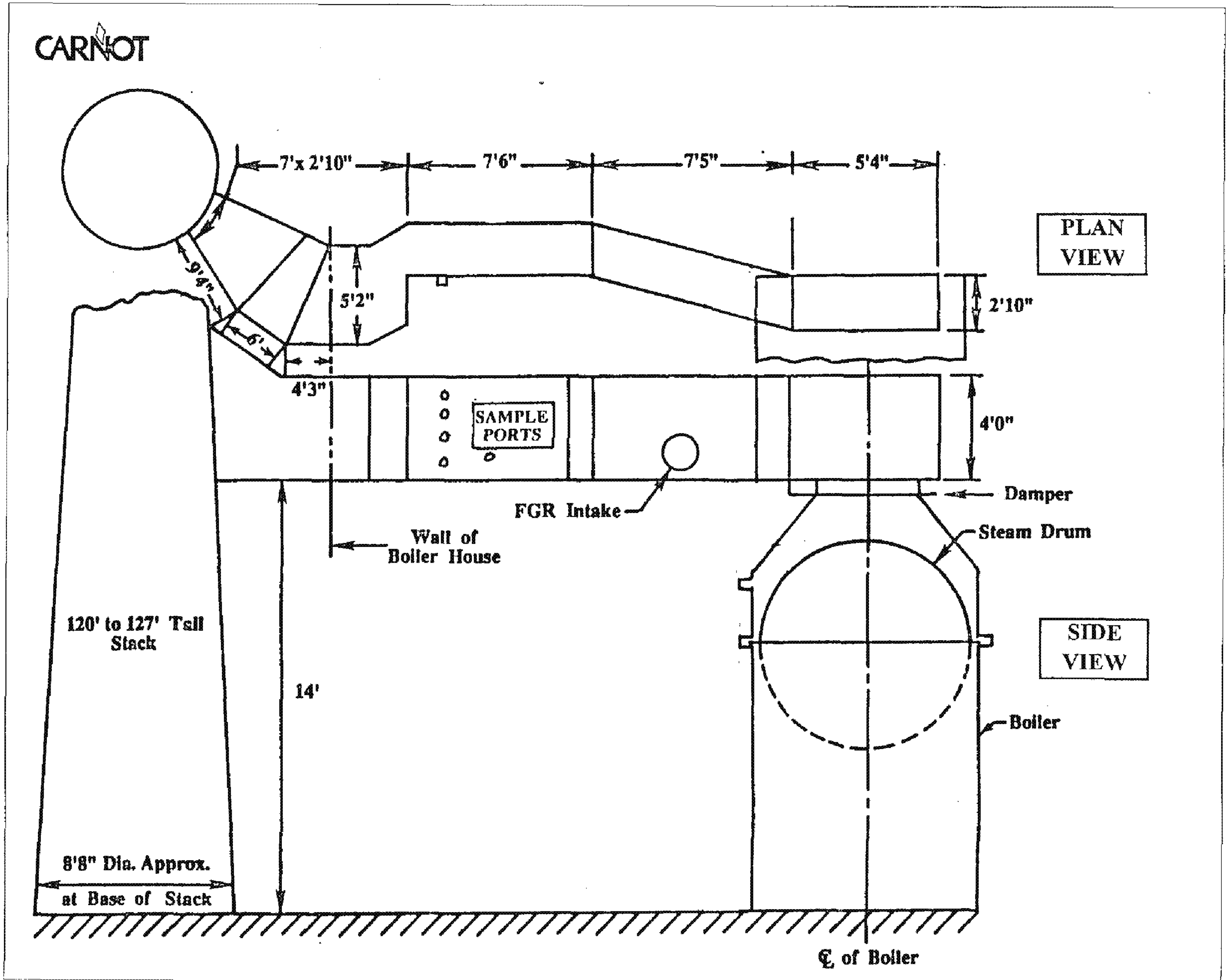


Figure 3-1. AWI Exhaust Duct Configuration

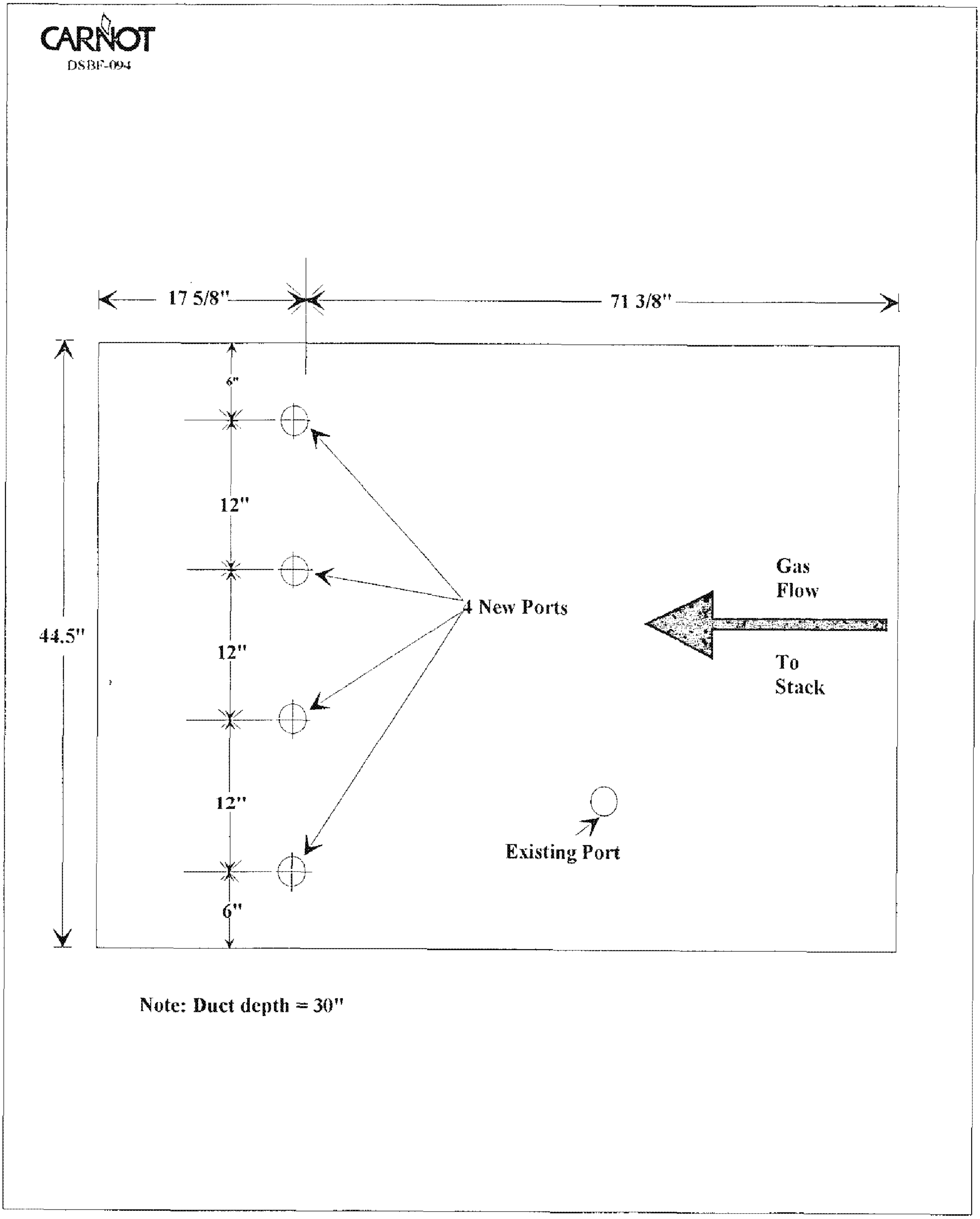


Figure 3-2. Detail of Sample Port Location

3.3 TEST PROCEDURES

Table 3-2 lists the test methods which were used during the compliance measurement program at AWI's South Gate facility. Testing consisted of one sixty-minute gaseous measurement run to determine compliance with the RECLAIM concentration limit; a three-run relative accuracy audit on the fuel meter was also performed during this same sixty-minute period. Specific details of the test methods are described in the sections below.

3.3.1 NO_x, O_2 and CO_2

Gaseous emissions (NO_x, O_2, CO_2) were measured per SCAQMD Method 100.1 using Carnot's continuous emissions monitoring system (CEMS). For the single boiler load condition, a 60-minute gaseous measurement run was conducted using a 12-point traverse of the duct, with sampling conducted for five minutes per traverse point. The twelve traverse points were located according to SCAQMD Method 1.1 criteria, and the actual CEMS traverse point measurements used are documented in Appendix C.1.

3.3.2 Moisture

Moisture content in the flue gas for use in the fuel meter relative accuracy audit calculations was determined per SCAQMD Method 4.1. The moisture train was operated concurrently with the sixty-minute gaseous measurement run. The stainless steel moisture probe was positioned at the center of the duct in the existing port shown on Figure 3-2.

3.3.3 Velocity

Flow measurements for use in the fuel meter relative accuracy audit were conducted three times during the gaseous and moisture measurement runs per SCAQMD Method 2.1 using an S-type pitot probe. Due to the low ΔP values at the traverse points, the velocity measurements were done with a low-range micromanometer, which was leak checked and leveled prior to each velocity traverse. The three velocity traverses were conducted at roughly twenty-minute intervals during the sixty-minute gaseous and moisture measurement runs. Sixteen traverse points, located according to SCAQMD Method 1.1 criteria, were used for each velocity traverse, and the actual velocity traverse point measurements used are documented in Appendix C.1.

TABLE 3-2
RECLAIM LARGE SOURCE COMPLIANCE TEST PROCEDURES
ARMSTRONG WORLD INDUSTRIES, INC.
SOUTH GATE FACILITY

Species	Units	Reference Method	Principle	Comments
NO_x	ppmv dry	SCAQMD 100.1	Chemiluminescence	12-point traverse
O_2	% vol. dry	SCAQMD 100.1	Electrochemical Cell	12-point traverse
CO_2	% vol. dry	SCAQMD 100.1	NDIR	12-point traverse
Moisture	%	SCAQMD 4.1	Gravimetric	Single point
Velocity	ft/sec	SCAQMD 2.1	Differential Pressure	16-point traverse, S-type pitot probe
Stack Flow	dscfm	SCAQMD 2.1	Calculated	---

3.4 FUEL FLOW MEASUREMENT

In order to verify the accuracy of the fuel meter, a three-run relative accuracy audit was conducted during the RECLAIM Large Source compliance testing on the boiler. Three stack flows, in dscfm, were calculated using the three measured velocity traverses and moisture from the single moisture run, and compared to three stack flows calculated using measured fuel flows and an EPA Method 19 F-factor for natural gas.

The fuel flow rate to the main burner was determined by Carnot at ten-minute intervals during the sixty-minute compliance measurement run. It should be noted that the index on the totalizing fuel meter has 1,000 actual cubic feet (acf) as its smallest moving digit; a sweep dial, with one revolution of the sweep dial equal to 100 acf is also included on the index. To obtain meaningful fuel flow rate measurements, Carnot measured the time required to meter 100 acf on the sweep dial using a stopwatch; these measurements were done every ten minutes. After converting the time on the stopwatch to minutes, the actual fuel flow in actual cubic feet per minute (acfm) was determined by dividing this time into 100 acf. The actual fuel flow rate in acfm was multiplied by pressure and temperature correction factors to obtain the fuel flow rate in standard cubic feet per minute (scfm).

3.5 COMPLIANCE DETERMINATION CALCULATIONS

In order to meet the requirements of SCAQMD Rule 2012, the boiler must meet the following two requirements:

1. At each load condition, the NO_x concentration corrected to 3% O_2 must not exceed the RECLAIM concentration limit of 30 ppmv NO_x at 3% O_2, and

2. The relative accuracy of the totalizing fuel meter must be determined by comparing the average of the three measured stack flow rates to the three stack flow rates calculated measured fuel flow and an EPA Method 19 F-factor.

3.5.1 Concentration Limit Compliance

The sixty-minute gaseous test run measured NO_x and O_2 concentrations in the flue gas from the boiler. The measured NO_x concentration was corrected to 3% O_2 using Equation 3-1:

$$(NO_x)_c = NO_x \; x \left[\frac{20.9 - 3\%}{20.9 - O_2}\right] \qquad \text{Eq. 3-1}$$

where:
- $(NO_x)_c$ = corrected NO_x concentration, ppmv dry at 3% O_2
- NO_x = measured NO_x concentration, ppmv dry
- O_2 = measured O_2 concentration, % vol. dry

The NO_x concentration corrected to 3% O_2 must not exceed the RECLAIM concentration limit of 30 ppmv NO_x at 3% O_2.

3.5.2 Fuel Meter Relative Accuracy Audit

As noted in Section 3.4, a three-run relative accuracy audit was conducted during the RECLAIM Large Source compliance testing on the boiler. Three stack flows, in dscfm, were calculated using the three measured velocity traverses and moisture from the single moisture run, and compared to three stack flows calculated using measured fuel flows and an EPA Method 19 F-factor for natural gas. The calculations used are outlined in the paragraphs below.

After each of the three velocity measurement runs, the velocity data (velocity head and temperature at each traverse point, stack static pressure) and moisture content of the flue gas from the single moisture run was used to determine the measured flue gas flow rate, *A*, using Equations 1a through 1h in Appendix E.

For the three twenty-minute relative accuracy periods, the average fuel flow rate in scfm, combined with the EPA Method 19 F-factor for natural gas, was used to determine calculated flue gas flow rates using Equation 3-2 below:

$$C = Q_f \; x \; F \; x \; HHV \; x \; \frac{MMBtu}{10^6 \; Btu} \; x \; \frac{20.9}{20.9 - O_2} \qquad \text{Eq. 3-2}$$

where:
- C = calculated flue gas flow rate, dscfm
- Q_f = average fuel flow, scfm
- F = EPA Method 19 F-factor for natural gas, 8,710 dscf/MMBtu
- HHV = higher heating value of natural gas, 1,050 Btu/scf
- O_2 = measured O_2 concentration in flue gas, % vol. dry

The relative accuracy of the fuel meter was then determined by taking the average of the measured flue gas flow rates, the average of the calculated EPA Method 19 flow rates, and inserting them into Equation 3-3:

$$RA = \frac{C_{avg} - A_{avg}}{A_{avg}} \; x \; 100\% \qquad \text{Eq. 3-3}$$

where:

RA = relative accuracy, %
C_{avg} = average calculated flue gas flow rate, dscfm
A_{avg} = average measured flue gas flow rate, dscfm

SECTION 4.0

RESULTS

Table 4-1 presents the results of the RECLAIM Large Source compliance testing and fuel meter relative accuracy audit for the process steam boiler at AWI's South Gate facility.

TABLE 4-1
RESULTS SUMMARY
RECLAIM LARGE SOURCE COMPLIANCE TESTING
PROCESS STEAM BOILER
ARMSTRONG WORLD INDUSTRIES, INC.
SOUTH GATE PLANT
SEPTEMBER 26, 1996

CONCENTRATION LIMIT COMPLIANCE

Test No.	Test Time	Measured Emissions (ppmv NO_x at 3% O_2)	Concentration Limit (ppmv NO_x at 3% O_2)
1-CEM	1300-1400	28.19	30

FUEL METER RELATIVE ACCURACY AUDIT

Test No.	Test Time	Actual Flow (dscfm)	Calculated Flow (dscfm)
1A-RAA	1300-1320	2,878.7	1,322.8
1B-RAA	1320-1340	2,301.4	1,372.5
1C-RAA	1340-1400	1,935.4	1,338.1
Average		2,371.8	1,344.4

Fuel Meter Relative Accuracy = -43.3%

As shown in Table 4-1, emissions of NO_x measured during the sixty-minute gaseous measurement run were 28.19 ppmv at 3% O_2, which is below the RECLAIM concentration limit of 30 ppmv NO_x at 3% O_2 specified for the boiler in the Facility Permit to Operate.

The agreement between actual and calculated stack flow rates is very poor, as shown by the relative accuracy of -43.3%. As can be seen in the velocity traverse data sheets included in Appendix C.4, the measured ΔPs at every traverse point were very low, with average values of 0.0183 iwg, 0.0110 iwg and 0.0078 iwg for tests 1A-RAA, 1B-RAA and 1C-RAA, respectively. As noted previously, these ΔPs were measured with a low-range micromanometer to ensure accurate measurements and care was taken to leak check and level the manometer before each velocity traverse. However, even with the use of the micromanometer, the SCAQMD may feel that these ΔP values are unacceptably low to measure accurately.

Section 2.0 notes the fact that the boiler is significantly oversized relative to the actual steam demands of AWI's manufacturing facility; as a consequence, the duct leading to the stack is also significantly oversized relative to the amount of flue gas flow passing through it. In addition, Figure 2-1 shows that the sample port location is downstream of the FGR intake, which removes a portion of the flue gas and sends it to the windbox of the main burner, further reducing the amount of flue gas passing the sample ports on the way to the stack. These two factors combine to produce the small ΔPs measured during the three velocity traverses. Due to programming of the boiler's Allen-Bradley control system, it was not possible to increase the boiler load to a higher level to produce higher ΔPs for the fuel meter relative accuracy determination.

It is felt that the poor agreement between actual and calculated stack flow rates is entirely due to the difficultly in obtaining meaningful stack flow rates in an oversized flue gas duct at a relatively low boiler load; **the high relative accuracy percentage is not an indication of the true accuracy of this fuel meter.**

APPENDIX A

MEASUREMENT PROCEDURES

Continuous Emissions Monitoring System

Oxygen (O_2) by Continuous Analyzer

Carbon Dioxide (CO_2) by Continuous Analyzer

NO/NO_x by Continuous Analyzer

Stack Gas Velocity and Volumetric Flow Rate

Determination of Moisture in Stack Gases

Continuous Emissions Monitoring System

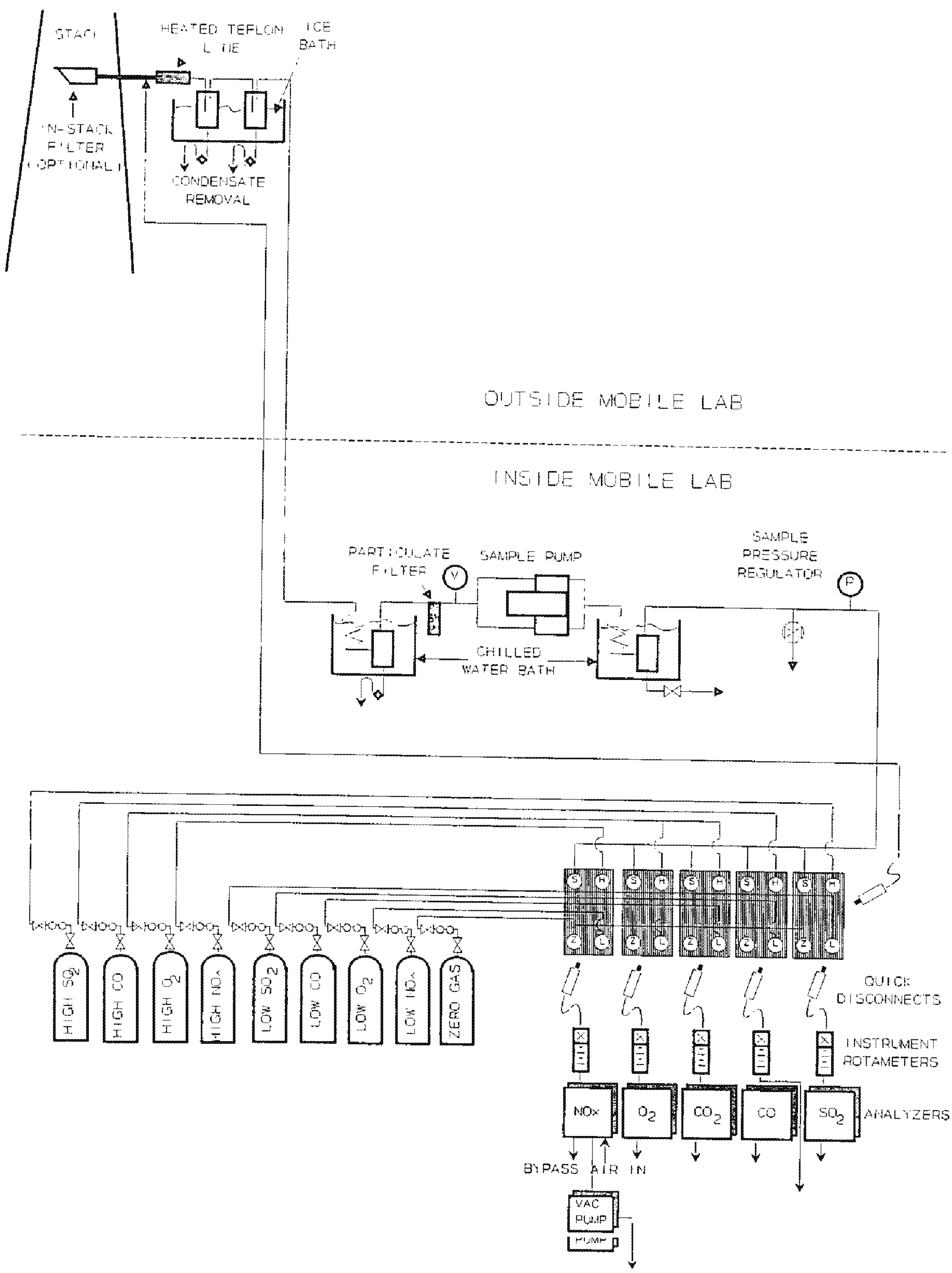
O_2, CO, CO_2, NO, NO_x and SO_2 are measured using an extractive continuous emissions monitoring (CEM) package, shown in the following figure. This package is comprised of three basic subsystems. They are: (1) the sample acquisition and conditioning system, (2) the calibration gas system, and (3) the analyzers themselves. This section presents a description of the sampling and calibration systems. Descriptions of the analyzers used in this program and the corresponding reference test methods follow. Information regarding quality assurance information on the system, including calibration routines and system performance data follows.

The sample acquisition and conditioning system contains components to extract a representative sample from the stack or flue, transport the sample to the analyzers, and remove moisture and particulate material from the sample. In addition to performing the tasks above, the system must preserve the measured species and deliver the sample for analysis intact. The sample acquisition system extracts the sample through a stainless steel probe. The probe is insulated or heated as necessary to avoid condensation. If the particulate loading in the stack is high, a sintered stainless steel filter is used on the end of the probe.

Where water soluble NO_2 and/or SO_2 are to be measured, the sample is drawn from the probe through a heated teflon sample line into an on-stack cooled (approximately 35-40°F) water removal trap. The trap consists of stainless steel flasks in a bath of ice and water. This design removes the water vapor by condensation. The contact between the sample and liquid water is minimized and the soluble NO_2 and SO_2 are conserved. This system meets the requirements of EPA Method 20. The sample is then drawn through a teflon transport line, particulate filter, secondary water removal and into the sample pump. The pump is a dual head, diaphragm pump. All sample-wetted components of the pump are stainless steel or teflon. The pressurized sample leaving the pump flows through a third condensate trap in a refrigerated water bath ($\approx$38°F) for final moisture removal. A drain line and valve are provided to constantly expel any condensed moisture from the dryer at this point. After the dryer, the sample is directed into a distribution manifold. Excess sample is vented through a back-pressure regulator, maintaining a constant pressure of 5-6 psig to the analyzer rotameters.

The calibration system is comprised of two parts: the analyzer calibration, and the system bias check (dynamic calibration). The analyzer calibration equipment includes pressurized cylinders of certified span gas. The gases used are, as a minimum, certified to 1% by the manufacturer. Where necessary to comply with reference method requirements EPA Protocol 1 gases are used. The cylinders are equipped with pressure regulators which supply the calibration gas to the analyzers at the same pressure and flow rate as the sample. The selection of zero, span, or sample gas directed to each analyzer is accomplished by operation of the sample/calibration selector fittings.

The system bias check is accomplished by transporting the same gases used to zero and span the analyzers to the sample system as close as practical to the probe inlet. This is done either by attaching the calibration gas supply line to the probe top with flexible tubing or by actuation of a solenoid valve located at the sample conditioner inlet (probe exit). The span gas is exposed to the same elements as the sample and the system response is documented. The analyzer indications for the system calibration check must agree within 5% of the analyzer calibration. Values are adjusted and changes/repairs are made to the system to compensate for any difference in analyzer readings. Specific information on the analytical equipment and test methods used is provided in the following pages.



Schematic of CEM System

Method:	**Oxygen (O_2) by Continuous Analyzer**
Applicable Reference Methods:	EPA 3A, EPA 20, ARB 100, BA ST-14, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of O_2 concentration.
Analyzer:	Teledyne Model 326A
Measurement Principle:	Electrochemical cell
Ranges:	0-5, 0-10, 0-25% O_2
Accuracy:	1% of full scale
Output:	0-100 mV, linear
Interferences:	Halogens and halogenated compounds will cause a positive interference. Acid gases will consume the fuel cell and cause a slow calibration drift.
Response Time:	90% <7 seconds
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously. If Method 20 is used, that method's specific procedures for selecting sample points are used. Otherwise, stratification checks are performed at the start of a test program to select single or multiple-point sample locations.
Analytical Procedure:	An electrochemical cell is used to measure O_2 concentration. Oxygen in the flue gas diffuses through a Teflon membrane and is reduced on the surface of the cathode. A corresponding oxidation occurs at the anode internally, and an electric current is produced that is proportional to the concentration of oxygen. This current is measured and conditioned by the instrument's electronic circuitry to give an output in percent O_2 by volume.
Special Calibration Procedure:	The measurement cells used with the O_2 instrument have to be replaced on a regular basis. After extended use, the cell tend to produce a nonlinear response. Therefore, a three-point calibration is performed at the start of each test day to check for linearity. If the response is not linear ($\pm$ 1% of scale), the cell is replaced.

Method:	**Carbon Dioxide (CO_2) by Continuous Analyzer**
Applicable Reference Methods:	EPA 3A, ARB 100, BA ST-5, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of CO_2 concentration.
Analyzer:	Horiba PIR 2000
Measurement Principle:	Non-dispersive infrared (NDIR)
Accuracy:	1% of full scale
Ranges:	0-5, 0-10, 0-25%
Output:	0-10 mV
Interferences:	A possible interference includes water. Since the instrument receives dried sample gas, this interference is not significant.
Response Time:	1.2 seconds
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously.
Analytical Procedure:	Carbon dioxide concentrations are measured by short path length non-dispersive infrared analyzers. These instruments measure the differential in infrared energy absorbed from energy beams passed through a reference cell (containing a gas selected to have minimal absorption of infrared energy in the wavelength absorbed by the gas component of interest) and a sample cell through which the sample gas flows continuously. The differential absorption appears as a reading on a scale of 0 to 100%.

Method:	**NO/NO_x by Continuous Analyzer**
Applicable Reference Methods:	EPA 7E, EPA 20; ARB 100, BA ST-13A, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of NO or NO_x.
Analyzer:	Teco Model No. 10AR
Measurement Principle:	Chemiluminescence
Accuracy:	1% of full scale
Ranges:	0-2.5, 0-10, 0-25, 0-100, 0-250, 0-1000, 0-2500, 0-10,000 ppm
Output:	0-10 mV
Inferences:	Compounds containing nitrogen (other than ammonia) may cause interference.
Response Time:	90%, 1.5 seconds (NO mode) and 1.7 seconds (NO_x mode)
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously. If EPA Method 20 is used, that method's specific procedures for selecting sample points are used.
Analytical Procedure:	The oxides of nitrogen monitoring instrument is a chemiluminescent nitric oxide analyzer. The operational basis of the instrument is the chemiluminescent reaction of NO and ozone (O_3) to form NO_2 in an excited state. Light emission results when excited NO_2 molecules revert to their ground state. The resulting chemiluminescence is monitored through an optical filter by a high sensitivity photomultiplier tube, the output of which is electronically processed so it is linearly proportional to the NO concentration. The output of the instrument is in ppmV. When NO_2 is expected to be present in the flue gas, a supercooled water dropout flask will be placed in the sample line to avoid loss of NO_2. Since NO_2 is highly soluble in water, "freezing out" the water will allow the NO_2 to reach the analyzers for analysis. The analyzer measures NO only. In the NO_x mode, the gas is passed through a moly converter which converts NO_2 to NO and a total NO_x measurement is obtained. NO_2 is determined as the difference between NO and NO_x. Use of a moly converter instead of a stainless steel converter eliminates NH_3 interference; NH_3 is converted to NO with a stainless converter, but not with a moly converter.

Method:	**Stack Gas Velocity and Volumetric Flow Rate**
Reference:	EPA Method 2, SCAQMD Method 2.1, ARB Method 2
Principle:	The average gas velocity in a stack is determined from the measurement of the gas density and from the measurement of the average velocity head using a Type-S (Stausscheibe) Pitot tube.
Sampling Procedure:	The velocity head and temperature are measured at traverse points specified by EPA Method 1 or SCAQMD Method 1.1. The velocity is measured using a Type-S Pitot tube and an inclined water manometer. The flow coefficient of the pitot tube is known. Temperature of the gas is measured using a thermocouple. The stack gas molecular weight is determined from independent measurements of O_2, CO_2, and H_2O concentrations.
Sample Analysis and Recovery:	The stack gas velocity is determined from the measured average velocity head, the measured average temperature, the measured average duct static pressure, the measured dry concentrations of O_2 and CO_2, and the measured concentration of H_2O. The velocity is determined from the following set of equations:

$$V_S = 2.90 C_p \sqrt{\Delta p T_s \left[\frac{29.92}{P_s}\right]\left[\frac{28.95}{MW_{wet}}\right]} \quad \text{[ft/s]}$$

Δp = *Velocity/Head, inches H_2O* [in. H_2O]

T_s = *Gas Temperature, degrees R* [R]

P_s = *Absolute Static Pressure* [in Hg]

C_p = *Pitot Flow Coefficient* [unitless]

$$MW_{wet} = \left[(0.44)(\%CO_2)+(0.32)(\%O_2)+(0.28)(\%N_2)\right](1-\frac{\%H_2O}{100})+(18)(\frac{\%H_2O}{100})$$

The stack gas volumetric flow rate is determined from the measured stack gas velocity, the area of the stack at the measurement plane, and the measured gas temperature and pressure. The volumetric flow rate is determined from the following set of equations:

$$Q = (V_s)(AREA)(60) \quad \text{[wacfm]}$$

$$Q_{ws} = Q\left[\frac{T_{ref}}{T_s}\right]\left[\frac{P_s}{29.92}\right] \quad \text{[wscfm]}$$

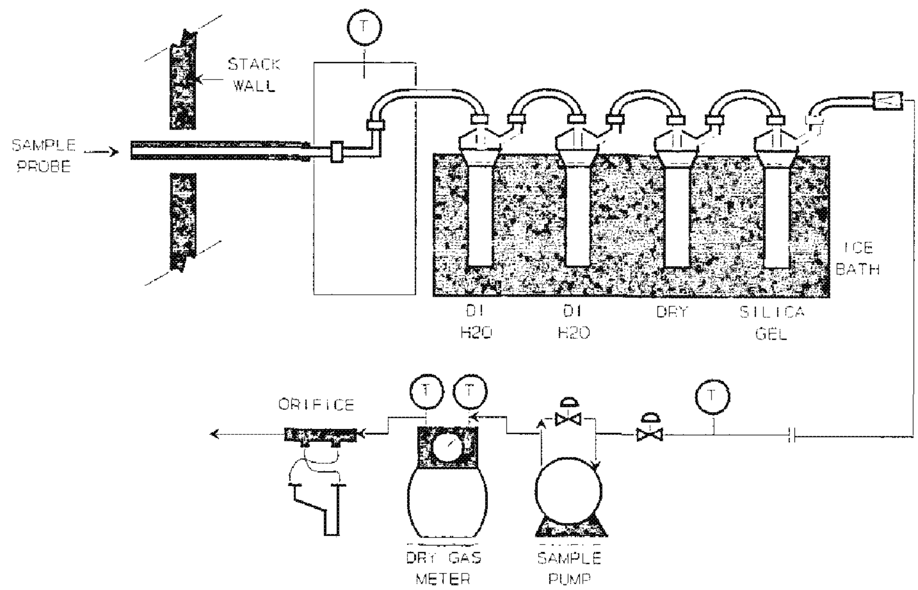
$$Q_{sd} = Q_{ws}\left[1-\frac{\%H_2O}{100}\right] \quad \text{[dscfm]}$$

Method: **Determination of Moisture in Stack Gases**

Applicable Ref. Methods: EPA 4, ARB 1-4, SCAQMD 4.1

Principle: A gas sample is extracted at a constant rate from the source; moisture is removed from the sample stream and determined volumetrically or gravimetrically.

Sampling Procedure: The sample train used in the tests is shown in the following figure. The sample is drawn at a constant rate through a stainless steel probe. The probe is connected to an impinger train by Teflon tubing. The train consists of two Greenburg-Smith impingers which contain 100 ml water, an empty impinger as a knockout, and an impinger containing silica gel to protect the pump from moisture.



Sample Train for Determination of Moisture by EPA Method 4

Sample Recovery and Analysis: Following testing, moisture content is determined gravimetrically from initial and final impinger weights.

APPENDIX B

QUALITY ASSURANCE

Appendix B.1

Quality Assurance Program Summary

QUALITY ASSURANCE PROGRAM SUMMARY AND ARB CERTIFICATION

Carnot ensures the quality and validity of its emission measurement and reporting procedures through a rigorous quality assurance (QA) program. The program is developed and administered by an internal QA Officer and encompasses seven major areas:

1. Development and use of an internal QA manual.
2. QA reviews of reports, laboratory work, and field testing.
3. Equipment calibration and maintenance.
4. Chain of custody.
5. Training.
6. Knowledge of current test methods.
7. Agency certification.

Each of these areas is discussed individually below.

<u>Quality Assurance Manual</u>. Carnot has prepared a QA Manual according to EPA guidelines. The manual serves to document and formalize all of Carnot's QA efforts. The manual is constantly updated, and each member of the Source Test Division is required to read and understand its contents. The manual includes details on the other six QA areas discussed below.

<u>QA Reviews</u>. Carnot's review procedure includes review of each source test report by the QA Officer, and spot check reviews of laboratory and field work.

The most important review is the one that takes place before a test program begins. The QA Officer works closely with Source Test Division personnel to prepare and review test protocols. Test protocol review includes selection of appropriate test procedures, evaluation of any interferences or other restrictions that might preclude use of standard test procedures, and evaluation and/or development of alternate procedures.

<u>Equipment Calibration and Maintenance</u>. The equipment used to conduct the emissions measurements is maintained according to the manufacturer's instructions to ensure proper operation. In addition to the maintenance program, calibrations are carried out on each measurement device according to the schedule outlined by the California Air Resources Board (CARB). The schedule for maintenance and calibrations are given in Tables B-1 and B-2. Quality control checks are also conducted in the field for each test program. The following is a partial list of checks made as part of each CEM system test series.

- Sample acquisition and conditioning system leak check.
- 2-point analyzer calibrations (all analyzers)
- 3-point analyzer calibrations (analyzers with potential for linearity errors).
- Complete system calibration check ("dynamic calibration" through entire sample system).

- Periodic analyzer calibration checks (once per hour) are conducted at the start and end of each test run. Any change between pre- and post-test readings are recorded.

- All calibrations are conducted using gases certified by the manufacturer to be + 1% of label value (NBS traceable).

Calibration and CEM performance data are fully documented, and are included in each source test report.

Chain of Custody. Carnot maintains full chain of custody documentation on all samples and data sheets. In addition to normal documentation of changes between field sample custodians, laboratory personnel, and field test personnel, Carnot documents every individual who handles any test component in the field (e.g., probe wash, impinger loading and recovery, filter loading and recovery, etc.).

Samples are stored in a locked area to which only Source Test Division personnel have access. Neither other Carnot employees nor cleaning crews have keys to this area.

Data sheets are copied immediately upon return from the field, and this first generation copy is placed in locked storage. Any notes made on original sheets are initialed and dated.

Training. Personnel training is essential to ensure quality testing. Carnot has formal and informal training programs which include:

1. Attendance at EPA-sponsored training courses.
2. Enrollment in EPA correspondence courses.
3. A requirement for all technicians to read and understand Carnot's QA Manual.
4. In-house training and QA meetings on a regular basis.
5. Maintenance of training records.

Knowledge of Current Test Methods. With the constant updating of standard test methods and the wide variety of emerging test methods, it is essential that any qualified source tester keep abreast of new developments. Carnot subscribes to services which provide updates on EPA and CARB reference methods, and on EPA, CARB and SCAQMD rules and regulations. Additionally, source test personnel regularly attend and present papers at testing and emission-related seminars and conferences. Carnot personnel maintain membership in the Air and Waste Management Association, the Source Evaluation Society, and the ASME Environmental Control Division.

AGENCY CERTIFICATION

Carnot is certified by the CARB as an independent source test contractor for gaseous and particulate measurements. Carnot is certified by the SCAQMD as an independent source test contractor for gaseous and particulate measurements using SCAQMD Methods 1, 2, 3, 4, 5, 6, 7 and 100.1. Carnot also participates in EPA QA audit programs for Methods 5, 6 and 7.

TABLE B-1
SAMPLING INSTRUMENTS AND EQUIPMENT CALIBRATION SCHEDULE
As Specified by the CARB

Instrument Type	Frequency of Calibration	Standard of Comparison or Method of Calibration	Acceptance Limits
Orifice Meter (large)	12 months	Calibrated dry test meter	± 2% of volume measured
Dry Gas Meter	12 months or when repaired	Calibrated dry test meter	± 2% of volume measured
S-Type Pitot (for use with EPA-type sampling train	6 months	EPA Method 2	Cp constant (+5%) over working range; difference between average Cp for each leg must be less than 2%
Vacuum Gauges Pressure Gauges	6 months	Manometer	± 3%
Field Barometer	6 months	Mercury barometer	± 0.2" Hg
Temperature Measurement	6 months	NBS mercury thermometer or NBS calibrated platinum RTD	± 4°F for <400°F ± 1.5% for >400°F
Temperature Readout Devices	6 months	Precision potentiometer	± 2% full scale reading
Analytical Balance	12 months (check prior to each use)	Should be performed by manufacturer or qualified laboratory	± 0.3 mg of stated weight
Probe Nozzles	12 Months	Nozzle diameter check micrometer	Range < ± 0.10 mm for three measurements
Continuous Analyzers	Depends upon use, frequency and performance	As specified by manufacturers operating manuals, EPA NBS gases and/or reference methods	Satisfy all limits specified in operating specifications

TABLE B-2
EQUIPMENT MAINTENANCE SCHEDULE
Based on Manufacturer's Specifications and Carnot Experience

Equipment	Performance Requirement	Maintenance Interval	Corrective Action
Pumps	1. Absence of leaks 2. Ability to draw manufacturer required vacuum and flow	Every 500 hours of operation or 6 months, whichever is less	1. Visual inspection 2. Clean 3. Replace worn parts 4. Leak check
Flow Measuring Device	1. Free mechanical movement 2. Absence of malfunction	Every 500 hours of operation or 6 months, whichever is less After each test, if used in H_2S sampling or other corrosive atmospheres	1. Visual inspection 2. Clean 3. Calibrate
Sampling Instruments	1. Absence of malfunction 2. Proper response to zero, span gas	As required by the manufacturer	As recommended by manufacturer
Integrated Sampling Tanks	Absence of leaks	Depends on nature of use	1. Steam clean 2. Leak check
Mobile Van Sampling Systems	Absence of leaks	Depends on nature of use	1. Change filters 2. Change gas dryer 3. Leak check 4. Check for system contamination
Sampling Lines	Sample degradation less than 2%	After each test or test series	Blow filtered air through line until dry

Appendix B.2

ARB Certification/SCAQMD LAP Letter

South Coast
Air Quality Management District
AQMD
21865 E. Copley Drive, Diamond Bar, CA 91765-4182 (909) 396-2000

RECEIVED
JUN 24 1996
CARNOT

June 21, 1996

Robert A. Finken
Carnot
So. Cal. Measurement Division
15991 Red Hill Avenue, Suite 110
Tustin, Ca. 92680

Laboratory: **Carnot, So. Cal. Measurement Div.**
Reference #: **93 LA 1103**
Application Date: **May 5, 1995**

Dear Mr. Finken:

I received your letter (via FAX) requesting renewal of your LAP approval (which had lapsed on 5/17/96) for **Rule 1420 Ambient Sampling** and **Rule 1420 Source Sampling** and I am pleased to inform you that your firm has been reapproved to perform this testing, with the understanding that District or other specified methods, procedures and policies must be strictly followed. Approval ensures that your lab/test facilities have demonstrated the capability to meet the District's testing and analysis requirements for the following methods:

SCAQMD Methods 1-4
SCAQMD Method 6.1 (Incl. 5)
SCAQMD Method 7.1 (Sampling)
SCAQMD Method 100.1 (Conditional)

Approval is granted for the period **beginning: November 16, 1995 and ending: November 16, 1996.**

Rule 1420 Ambient Sampling (without modeling)
Rule 1420 Source Sampling

Approval is granted for the period **beginning: June 21, 1996 and ending: June 21, 1997.**

State of California

Air Resources Board

Approved Independent Contractor

Carnot

This is to certify that the company listed above has been approved by the Air Resources Board to conduct compliance testing pursuant to Section 91207, Title 17, California Code of Regulations, until June 30, 1997, for those test methods listed below:

ARB Source Test Methods:
1, 2, 3, 4, 5, 8

James J. Morgester, Chief
Compliance Division

90 56165

State of California

Air Resources Board

Approved Independent Contractor

Carnot

This is to certify that the company listed above has been approved by the Air Resources Board to conduct compliance testing pursuant to Section 91207, Title 17, California Code of Regulations, until June 30, 1997, for those test methods listed below:

ARB Source Test Methods:
10, 100 (CO_2, O_2, SO_2)

James J. Morgester, Chief
Compliance Division

90 58165

State of California

Air Resources Board

Approved Independent Contractor

Carnot

This is to certify that the company listed above has been approved by the Air Resources Board to conduct compliance testing pursuant to Section 91207, Title 17, California Code of Regulations, until June 30, 1997, for those test methods listed below:

ARB Source Test Method 100 NOx

James J. Morgester, Chief
Compliance Division

90 56165

Appendix B.3

Quality Assurance Data

CARNOT

CEM PERFORMANCE DATA

CLIENT/LOCATION: ARMSTRONG/SOUTH GATE DATE: 9/26/96

TRUCK/CEM ID: ES-50 BY: BAF

SYSTEM CONFIGURATION

ANALYZERS IN SERVICE

ANALYZERS:	O_2	CO_2	CO	NO_x
MODEL:	Teledyne 326A	Horiba PIR-2000	—	TECO 10AR
SERIAL NO.:	N/A	802035	—	10A/R-20727-192

PROBE AND HEATED LINE	SAMPLE CONDITIONER
LENGTH/DIAMETER: 3.5' / 5/8" OD	CONDENSER-VACUUM SIDE (CHECK FLOW): ✓
LINER MATERAL: Stainless Steel	CONDENSER-PRESSURE SIDE (CHECK FLOW): ✓
HEATED PROBE (Y/N): Y	CONDENSER TEMPERATURE: 32°
HEATED LINE (Y/N): Y	FILTER CONDITION (COND. OR DATE LAST CHANGED): ✓
HEATED LINE TEMP: 221°	

SAMPLE LINE	SYSTEM LEAK CHECK
LENGTH: 75'	PRE-TEST (cfh): 0.00 cfh @ 21"Hg
LINER MATERIAL: Teflon	POST-TEST (cfh): —
DIAMETER: 3/8"	LEAK RATE (%) =
SYSTEM BIAS LINE: 1/4" Polyflow	$\frac{\text{POST - TEST (cfh)}}{\text{SYSTEM FLOW RATE(cfm)} \times 60} \times 100 =$ ______ %

ON-STACK CONDITIONER	NO_x CONVERSION EFFICIENCY
IN SERVICE (Y/N): Y	NO_2 CYLINDER No.:
KNOCK-OUT CONDITION (CHECK FLOW): OK ✓	NO_2 ppm/(as found): SEE FOLLOWING
COOLANT: ICE/H_2O	HIGH CAL NO_x: TWO PAGES
TEMPERATURE: 35°	HIGH CAL NO/(as found):

OPERATING CONDITIONS

	SYSTEM RESPONSE TIME CHECK
SAMPLE PRESSURE: 5" Hg	
SAMPLE VACUUM: 9" Hg	UPSCALE: 25 sec. 23 sec. 23 sec. 24 avg.
NO_x VACUUM: 28" Hg	DOWNSCALE: 24 sec. 25 sec. 25 sec. 25 avg.

NO_2 CONVERTER EFFICIENCY DATA AND CALCULATIONS

Client: --
Location: Shop
CEM I.D.: ES-50

Performed By: CH
Analyzer Serial #: 10AR-20727-192

Analyzer Range:	100	ppm		
Low Cal Gas Value:	0.00	ppm		
High Cal Gas Value:	89.12	ppm	Cylinder #:	AAL18295
NO2 Cal Gas Value:	89.34	ppm	Cylinder #:	ALM052501

Test Sequence	Date (m/d/y)	Time (hr:min)	Reference Value (ppm)	Analyzer Response (ppm)	Efficiency (%)	Absolute Deviation (%)
Low	9/3/96	17:08	0	-0.03		
High	9/3/96	17:18	89.12	89.34		
NO_2 #1	9/3/96	17:31	89.34	83.39	93.3%	0.8%
NO_2 #2	9/3/96	17:33	89.34	84.07	94.1%	0.1%
NO_2 #3	9/3/96	17:36	89.34	84.91	95.0%	0.9%
Low	9/3/96	17:36	0	0.16		
High	9/3/96	17:42	89.12	89.14		

Average NO_2 Response:	84.1	
Average (uncorrected) Efficiency:	94.2%	
Corrected Efficiency:	94.0% PASS	(>90% requirement)
Mean Deviation:	0.6% PASS	(<5% requirement)

NO_x = 89.12 (AAL 18295) 55-60 (10A2-20727-192)

NO_2 = 89.34 (ALM 052501)

Performed By CH

MANUAL Sep. 03.96 17:42
O2 15.62% CO2 0.00% NOx 89.14ppm CO 1.6ppm
O2avg1 15.57% CO2avg1 0.01% COavg1 1.7ppm O2avg2 15.36%
CO2avg2 0.00% COavg2 1.5ppm

SPAN

84.76ppm O2avg1 15.33% CO2avg1 0.00% COavg1 1.5ppm
CO2 Sep.03 17:39

0.0 40.0 80.0 120.0 160.0 200.0 ppm

CO O2

MANUAL Sep. 03.96 17:36
O2 15.46% CO2 0.02% NOx 0.16ppm CO 1.8ppm
O2avg1 15.29% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.29%
CO2avg2 0.00% COavg2 1.4ppm

Zero

O2

MANUAL Sep. 03.96 17:36
O2 15.45% CO2 0.01% NOx 84.91ppm CO 1.6ppm
O2avg1 15.28% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.28%
CO2avg2 0.00% COavg2 1.4ppm

NO_2 #3

0.0 40.0 80.0 120.0 160.0 200.0 ppm

CO

MANUAL Sep. 03.96 17:34
O2 15.46% CO2 0.00% NOx 0.15ppm CO 1.3ppm
O2avg1 15.25% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.25%
CO2avg2 0.00% COavg2 1.4ppm

0 10 20 30 40 50 60 70 80 90 100

NOx

MANUAL Sep. 03.96 17:33
O2 15.37% CO2 0.01% NOx 84.07ppm CO 1.4ppm
O2avg1 15.24% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.24%
CO2avg2 0.00% COavg2 1.4ppm

NO_2 #2

CO2

MANUAL Sep. 03.96 17:32
O2 15.34% CO2 0.00% NOx 0.14ppm CO 1.4ppm
O2avg1 15.22% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.22%
CO2avg2 0.00% COavg2 1.4ppm

O2

MANUAL Sep. 03.96 17:31
O2 15.30% CO2 0.00% NOx 83.39ppm CO 1.2ppm
O2avg1 15.21% CO2avg1 0.00% COavg1 1.4ppm O2avg2 15.21%
CO2avg2 0.00% COavg2 1.4ppm

NO_2 #1

0.0 40.0 80.0 120.0 160.0 200.0 ppm

CO

NOx

14.35% CO2avg2 0.01% COavg2 1.6ppm
Sep.03 17:24
61.10ppm O2avg1 14.72% CO2avg1 0.00% COavg1 1.5ppm
Sep.03 17:24

CO2

O2

0.00 20.00 40.00 60.00 80.00 100.00 ppm

NOx

CO

MANUAL Sep. 03.96 17:18
O2 14.90% CO2 0.01% NOx 89.34ppm CO 1.4ppm
O2avg1 14.58% CO2avg1 0.00% COavg1 1.4ppm O2avg2 14.21%
CO2avg2 0.00% COavg2 1.5ppm

NO_x SPAN

0 10 20 30 40 50 60 70 80 90 100

NOx

CO2

O2

79.40ppm O2avg1 6.48.96% CO2avg1 0.00 0.01% COavg2 15.00 1.5ppm 20.00 25.00 %
CO2 Sep.03 17:09

CO

MANUAL Sep. 03.96 17:08
O2 14.41% CO2 0.01% NOx -0.03ppm CO 1.4ppm
O2avg1 13.95% CO2avg1 0.01% COavg1 1.5ppm O2avg2 13.95%
CO2avg2 0.01% COavg2 1.5ppm

Zero

NOx 16:19 17:07 300mm/h

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: ARMSTRONG WORLD INDUSTRIES, INC. DATE: 9/26/96
RECLAIM LARGE SOURCE COMPLIANCE BY: BAF

	MID SPAN CYLINDER		HIGH SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO	AAL15800			
O_2	ALM055244	5.526	ALM006096	9.024
CO_2	ALM055244	14.99	ALM006096	22.4
NO_x	ALM045897	10.99	ALM002366	22.72
NO_x	ALM002366	22.72	ALM062183	51.12
NO_x				

PRE-TEST INSTRUMENT CALIBRATION ERROR

	ANALYZER					STATUS
	O_2	CO_2	NO_x	NO_x	NO_x	
Analyzer Range	10	25	25	55	0	
Zero Gas Value	0	0	0	0		--
Analyzer Reads	0.07	0.00	0.01	-0.02		--
Error (% of scale)	0.7%	0.0%	0.0%	0.0%		PASS
High Gas Value	9.024	22.4	22.72	51.12		--
Analyzer Reads	9.02	22.38	22.62	51.08		--
Error (% of scale)	0.0%	-0.1%	-0.4%	-0.1%		PASS
Mid Gas Value	5.526	14.99	10.99	22.72		--
Analyzer Reads	5.55	14.97	11.05	22.70		--
Error (% of scale)	0.2%	-0.1%	0.2%	0.0%		PASS

POST-TEST INSTRUMENT CALIBRATION ERROR

	ANALYZER					STATUS
	O_2	CO_2	NO_x	NO_x	NO_x	
Analyzer Range	10	25	0	55	0	
Zero Gas Value	0	0	RANGE NOT USED	0		--
Analyzer Reads	0.03	0.01		-0.20		--
Error (% of scale)	0.3%	0.0%		-0.4%		PASS
High Gas Value	9.024	22.4		51.12		--
Analyzer Reads	9.01	22.22		51.65		--
Error (% of scale)	-0.1%	-0.7%		1.0%		PASS
Mid Gas Value	5.526	14.99		22.72		--
Analyzer Reads	5.56	14.97		23.02		--
Error (% of scale)	0.3%	-0.1%		0.5%		PASS

% ERROR CALCULATION:

(AS FOUND - ACTUAL VALUE OF SPAN)/RANGE * 100%

ALLOWABLE DEVIATION IS 2% OF FULL SCALE (2 SQUARES ON STRIPCHART)

Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 Fax: (909) 887-0549

CERTIFICATE OF ANALYSIS

CARNOT

15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-37526-001
PO#: 11-0283
ITEM #: 0201811 AL
DATE: 4/25/95

CYLINDER #: AAL15800
FILL PRESSURE: 2200 PSIG

PURE MATERIAL: NITROGEN CAS# 7727-37-9

GRADE: U Z A M

PURITY: 99.999%

IMPURITY	MAXIMUM CONCENTRATIONS	ACTUAL CONCENTRATIONS
THC	0.05 PPM	<0.05 PPM
CO	0.05 PPM	<0.05 PPM
O2	2 PPM	<2 PPM
CO2	1 PPM	<1 PPM
NOX	0.005 PPM	<0.005 PPM
SF6	0.001 PPM	<0.001 PPM
SO2	0.005 PPM	<0.005 PPM
H2O	4 PPM	<4 PPM

2200 PSIG 4/25/95

QC BATCH : 0522

ANALYST: Diana Hardin
DMH

Scott Specialty Gases

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA Protocol Gas

Customer
CARNOT
15991 RED HILL AVE
SUITE 110
TUSTIN, CA 92680

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order: 11-1402
Scott Project #: 46984.02A
CGA Fitting: 590

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability for Assay and Certification of Gaseous Calibration Standards; Procedure G1; September 1993.

Cylinder Number: ALM006096 **Certification Date:** 05/29/96 **Exp. Date:** 05/29/99
Cylinder Pressure: 1900 PSIG **Previous Certification Date:** None **Bin No.:** 4

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
CARBON DIOXIDE	22.4 %	±2% NIST TRACEABLE
OXYGEN	9.024 %	±1% NIST TRACEABLE
Nitrogen	Balance Gas	

*Analytical uncertainty is inclusive of usual known error sources which at least include the precision of the measurment processes.

REFERENCE STANDARD

Type/SRM Sample No.	Expiration Date	Cylinder Number	Concentration
NTRM 18000	12/21/96	ALM047718	17.95% CO2/N2
CRM 2659	10/01/96	ALM017721	20.63% O2/N2

INSTRUMENTATION

Instrument/Model/Serial#	Last Date Calibrated	Analytical Principle
Horiba/OPE-135C/565607122	05/29/96	NDIR
Horiba/OPE-335/850557042	05/23/96	Magnetopneumatic

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
CARBON DIOXIDE	Date: 05/29/96 Response Units: mv Z1=0.00 R1=92.3 T1=70.1 R2=92.3 Z2=0.00 T2=70.1 Z3=0.00 T3=70.1 R3=92.3 Avg. Conc. of Cust Cyl. 22.4%	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=Ax3+Bx2+Cx+Dx A=0.00001001 B=-0.00006681 C=0.1178 D=-0.1761 r=0.99999
OXYGEN	Date: 05/29/96 Response Units: mv Z1=0.00 R1=82.4 T1=36.1 R2=82.4 Z2=0.00 T2=36.1 Z3=0.00 T3=36.1 R3=82.4 Avg. Conc. of Cust Cyl. 9.024%	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=Ax+B A=0.2501 B=-0.003409 r=0.99999
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes: Do not use when cylinder pressure is below 150 psig.
ATTN: RICK MADRIGAL

Reviewed and Approved by:

Scott Specialty Gases

RECEIVED

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) [illegible]

AUG 2 0 1996

CARNOT

CERTIFICATE OF ANALYSIS: EPA Protocol Gas

Customer
CARNOT
15991 RED HILL AVE
SUITE 110
TUSTIN, CA 92680

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order: 11-1655
Scott Project #: 48721.03A
CGA Fitting: 590

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability for Assay and Certification of Gaseous Calibration Standards; Procedure G1; September 1993.

Cylinder Number: ALM055244 **Certification Date:** 08/09/96 **Exp. Date:** 08/09/99
Cylinder Pressure: 1900 PSIG **Previous Certification Date:** None **Bin No.:** 1

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
CARBON DIOXIDE	14.99 %	±1% NIST TRACEABLE
OXYGEN	5.526 %	±1% NIST TRACEABLE
Nitrogen	Balance Gas	

*Analytical uncertainty is inclusive of usual known error sources which at least include the precision of the measurment processes.

REFERENCE STANDARD

Type/SRM Sample No.	Expiration Date	Cylinder Number	Concentration
NTRM 18000	12/21/96	ALM047718	17.95% CO2/N2
NTRM 2658	11/23/96	ALM03174	9.68% O2/N2

INSTRUMENTATION

Instrument/Model/Serial#	Last Date Calibrated	Analytical Principle
Horiba/OPE-135C/56553902	07/09/96	NDIR
Horiba/OPE-335/850557042	08/09/96	Magnetopneumatic

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
CARBON DIOXIDE	Date: 08/09/96 Response Units: mv Z1=0.00 R1=92.2 T1=83.4 R2=92.2 Z2=0.00 T2=83.4 Z3=0.00 T3=83.4 R3=92.2 Avg. Conc. of Cust Cyl. 14.99%	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=Ax3+Bx2+Cx+Dx A=.00001000 B=.00006680 C=.1178 D=.1760 r=0.99999
OXYGEN	Date: 08/09/96 Response Units: mv Z1=0.00 R1=96.9 T1=55.3 R2=96.9 Z2=0.00 T2=55.3 Z3=0.00 T3=55.3 R3=96.9 Avg. Conc. of Cust Cyl. 5.526%	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=Ax+B A=.09997 B=.002204 r=0.99999
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes: Do not use when cylinder pressure is below 150 psig.

Reviewed and Approved by: ____

Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer			Assay Laboratory
CARNOT	PROJECT #	41344.02B	Scott Specialty Gases
15991 RED HILL AVE	P.O. #	11.0901	2600 Cajon Boulevard
SUITE 110			San Bernardino, CA 92411
TUSTIN, CA 92680			

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay and Certification of Gaseous Calibration Standards; Procedure G1; September 1993.

Cylinder Number	ALM045897	Certification Date	09/25/95	Exp. Date	09/25/97
Cylinder Pressure	2000 PSIG				

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
(NITRIC OXIDE)	10.66 PPM	±1% NIST TRACEABLE
TOTAL OXIDES OF NITROGEN	10.99 PPM	REFERENCE VALUE ONLY
(Nitrogen)	Balance Gas	

+Do not use when cylinder pressure is below 150 psig.

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes.

REFERENCE STANDARD

Type/SRM Sample No.	Expiration Date	Cylinder Number	Concentration
NTRM 2629	11/21/96	ALM008353	19.86 PPM NO/N2

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR/#10	09/28/95	Chemi-Luminescent

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
NITRIC OXIDE	Date: 09/19/95 Response Units: mv Z1= 24.8 R1= 23592 T1= 12505 R2= 23578 Z2= 30.5 T2= 12638 Z3= 28.0 T3= 12663 R3= 23575 Avg. Conc. of Cust Cyl. 10.64 PPM	Date: 09/25/95 Response Units: mv Z1= 0.00 R1= 20.11 T1= 10.92 R2= 20.13 Z2= 0.09 T2= 10.96 Z3= 0.09 T3= 10.92 R3= 20.08 Avg. Conc. of Cust Cyl. 10.69 PPM	Concentration= Ax + B A =0.9815 B =-0.0380
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=
	Date: Response Units:mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units:mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes:

Analyst: Diana Hardin

Scott Specialty Gases

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA Protocol Gas

Customer	Assay Laboratory	
CARNOT	Scott Specialty Gases	**Purchase Order:** 11-1402
15991 RED HILL AVE	2600 Cajon Boulevard	**Scott Project #:** 0246984.04A
SUITE 110	San Bernardino, CA 92411	**CGA Fitting:** 660
TUSTIN, CA 92680		

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability for Assay and Certification of Gaseous Calibration Standards; Procedure G1; September 1993.

Cylinder Number: ALM002366 **Certification Date:** 06/12/96 **Exp. Date:** 06/12/98
Cylinder Pressure: 2000 PSIG **Previous Certification Date:** None **Bin No.:** 8

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	22.37 PPM	±1% NIST TRACEABLE
TOTAL OXIDES OF NITROGEN	22.72 PPM	REFERENCE VALUE ONLY
Nitrogen (Oxygen Free)	**Balance Gas**	

*Analytical uncertainty is inclusive of usual known error sources which at least include the precision of the measurment processes.

REFERENCE STANDARD

Type/SRM Sample No.	Expiration Date	Cylinder Number	Concentration
NTRM 0025	04/05/97	ALM042674	24.35 PPM NO/N2

INSTRUMENTATION

Instrument/Model/Serial#	Last Date Calibrated	Analytical Principle
TECO/10 AR/14853-151	06/04/96	Chemiluminescence

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
NITRIC OXIDE	Date: 06/05/96 Response Units: mv Z1=0.0041 R1=0.9790 T1=0.8866 R2=0.9774 Z2=0.0025 T2=0.8870 Z3=0.0018 T3=0.8890 R3=0.9789 Avg. Conc. of Cust Cyl. 22.382	Date: 06/12/96 Response Units: mv Z1=0.0004 R1=0.9793 T1=0.8874 R2=0.9757 Z2=0.0022 T2=0.8875 Z3=0.0020 T3=0.8842 R3=0.9774 Avg. Conc. of Cust Cyl. 22.354	Concentration=Ax+B A=25.040 B=01586 r=0.99999
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes: Do not use when cylinder pressure is below 150 psig.

Reviewed and Approved by: Diana Hardin

Scott Specialty Gases

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA Protocol Gas

Customer	Assay Laboratory	
CARNOT	Scott Specialty Gases	**Purchase Order:** 11-1655
15991 RED HILL AVE	2600 Cajon Boulevard	**Scott Project #:** 48721.04B
SUITE 110	San Bernardino, CA 92411	**CGA Fitting:** 660
TUSTIN, CA 92680		

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability for Assay and Certification of Gaseous Calibration Standards; Procedure G1; September 1993.

Cylinder Number: ALM062183 **Certification Date:** 05/31/96 **Exp. Date:** 05/31/98
Cylinder Pressure: 2000 PSIG **Previous Certification Date:** None **Bin No.:** 0

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	49.38 PPM	±1% NIST TRACEABLE
TOTAL OXIDES OF NITROGEN	51.12 PPM	REFERENCE VALUE ONLY
Nitrogen (Oxygen Free)	**Balance Gas**	

*Analytical uncertainty is inclusive of usual known error sources which at least include the precision of the measurment processes.

REFERENCE STANDARD

Type/SRM Sample No.	Expiration Date	Cylinder Number	Concentration
NTRM 1683	12/05/97	ALM056919	49.4 PPM NO/N2

INSTRUMENTATION

Instrument/Model/Serial#	Last Date Calibrated	Analytical Principle
TECO/10 AR/14853-151	05/31/96	Chemiluminescence

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
NITRIC OXIDE	Date: 05/21/96 Response Units: mv Z1=0.0027 R1=0.4949 T1=0.4975 R2=0.4961 Z2=0.0014 T2=0.4949 Z3=0.0009 T3=0.4946 R3=0.4948 Avg. Conc. of Cust Cyl. 49.527 PPM	Date: 05/31/96 Response Units: mv Z1=0.0018 R1=0.9444 T1=0.4916 R2=0.9411 Z2=0.0009 T2=0.4898 Z3=-0.0001 T3=0.4926 R3=0.9443 Avg. Conc. of Cust Cyl. 49.225 PPM	Concentration=Ax+B A=100.07 B=0.05867 r=0.99999
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=
	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes: Do not use when cylinder pressure is below 150 psig.

Reviewed and Approved by:

ES-19

CARNOT DRY GAS METER CALIBRATION

LONG FORM

FIELD METER INFO.		TEST METER INFO.		ALLOWABLE CRITERIA
FIELD GAS METER ID :	ES-19	TEST METER ID.	APEX RENTAL SER # 1039845	INDIVIDUAL Yd=0.01
CALIBRATION DATE:	7/18/96	TEST METER LAST C	7/11/96	Yd <=2% OF GEN AVG.
FIELD METER LAST Yd:	0.9873	TEST METER Yd FACTOR	0.991854	0.97<AVG. Yd>1.03
BAROMETRIC PRESSURE:	30.02	LEAK CHECK IN/OUT	OK	H@<=0.2 OF AVG. H@
CALIBRATION BY:	ms	DATA INPUT BY	MS	

FIELD METER				TEST METER				RESULTS			
VOLUME cu.ft.	TEMP ave'F	DELTA H "H2O	TIME min.	VOLUME cu.ft.	TEMP. 'F	PRESS. "H20	Q cfm	Y	H@	AVE.Y	AVG. H@
5.188	91.0	0.2	18	5.076	70	-0.01	0.288	1.0084	1.386		
5.492	92.0	0.2	19	5.356	70	-0.01	0.289	1.0069	1.385	1.0070	1.3856
5.491	90.8	0.2	19	5.36	70	-0.01	0.289	1.0057	1.386		
5.3	72.5	0.8	10	5.375	67	-0.025	0.530	1.0143	1.566		
5.337	78.0	0.8	10	5.373	67.5	-0.025	0.534	1.0164	1.554	1.0161	1.5542
5.922	84.3	0.8	11	5.905	68	-0.025	0.538	1.0175	1.542		
5.97	86.3	1	10	5.917	69	-0.035	0.597	1.0126	1.588		
5.964	92.0	1	10	5.89	69.5	-0.035	0.596	1.0186	1.589	1.0152	1.5898
5.984	91.8	1	10	5.893	70	-0.035	0.598	1.0144	1.591		
6.652	91.8	2	8	6.574	69	-0.06	0.832	1.0173	1.639		
5.765	91.0	2	7	5.7	68	-0.06	0.824	1.0183	1.665	1.0175	1.6492
6.628	89.0	2	8	6.581	69	-0.06	0.829	1.0169	1.644		
8.596	89.9	3.5	8	8.625	69	-0.1	1.075	1.0255	1.684		
5.377	90.3	3.5	5	5.386	69	-0.1	1.075	1.0245	1.686	1.0262	1.6838
5.378	93.3	3.5	5	5.38	69	-0.1	1.076	1.0287	1.681		

5 CU. FT. /RUN IS SATISFIED

AVERAGE Yd = 1.0164
AVERAGE DELTA H@ = 1.57
AVERAGE cfm @^H=1.0 = 0.597

PASS-INDIVIDUAL Yd VALUES MEET (0.01) LIMITS
PASS -INDIVIDUAL Yd VALUES WITHIN (.98/1.03) LIMITS
PASS - POST TEST Yd WITHIN LIMITS
PASS- DELTA H@ VALUES WITHIN ALLOWABLE (.2) LIMITS

CARNOT

PITOT TUBE DIMENSIONAL CALIBRATION

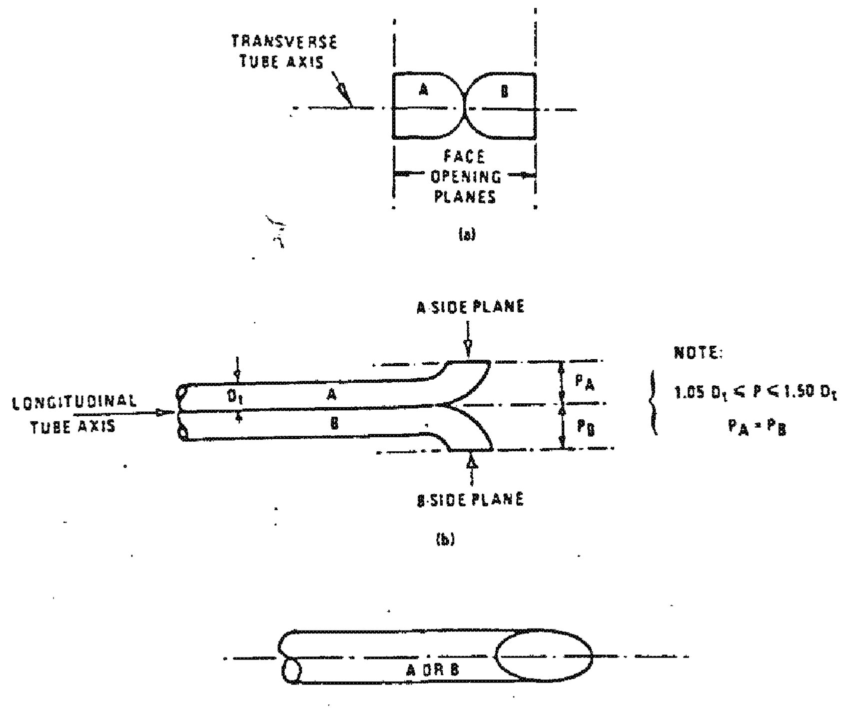
Pitot Tube I.D. 10C1 Date 7-19-98 By [illegible]

D_t .382 P_A .520 P_B .522

(a) Face opening plane angle = 90 deg (Y/N) A Y B Y

(b) Face opening planes parallel to longitudinal axis (Y/N) A Y B Y

(c) Both legs equal length and centerline coincident View (Y/N) A Y B Y



Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

Appendix B.4

Statement of Carnot's Compliance With SCAQMD Rule 304(k)

STATEMENT OF INDEPENDENT LABORATORY COMPLIANCE WITH SCAQMD RULE 304(k)

Carnot is an employee owned and operated company incorporated in the state of California. Carnot is certified by the SCAQMD as an independent testing laboratory and is in no way affiliated with Armstrong World Industries, Inc., except as a hired consultant.

1) Carnot has no financial interest in Armstrong World Industries, Inc. or the facility being tested, or in the parent company or any subsidiary thereof;

2) Armstrong World Industries, Inc. or the facility being tested, its parent company or any subsidiary thereof, has no financial interest in Carnot;

3) Any company or facility responsible for the emission of significant quantities of pollutants to the atmosphere or parent company or any subsidiary thereof, has no financial interest in Carnot; and

4) Carnot has no partnership with, owns or is owned by, in part or in full, the contractor who provided or installed equipment (basic or control), or monitoring systems, or is providing maintenance for installed equipment or monitoring systems for Armstrong World Industries, Inc.

Robert A Finken Date: 5/24/96

Robert A. Finken
Vice President
Southern California Measurement Division

Appendix B.5

Certification of No Exceptions to Standard Protocol

RECEIVED
OCT - 2 1996
CARNOT

CERTIFICATION of NO EXCEPTIONS

Facility ID 012155

Facility Name ARMSTRONG WORLD INDUSTRIES, INC.

Equipment Address 5037 PATATA STREET

SOUTH GATE, CA 90280-3555

Equipment Tested NATURAL GAS BOILER

Device ID D156

Standard Protocol Used SP-B-001

I hereby certify that no exceptions were made to the source test methods as written in the above referenced standard protocol used to source test the above referenced equipment for compliance with Rule 2012.

Facility Representative William Scott Woyshner **Date** 10/1/96

Signature

WILLIAM SCOTT WOYSHNER
ENVIRONMENTAL SPECIALIST
(213) 562-7227

APPENDIX C

REFERENCE METHOD DATA

Appendix C.1

Sample Location

SAMPLE POINT LOCATION DATA
SCAQMD METHOD 1.1

Location:	ARMSTRONG WORLD INDUSTRIES, INC.	Date:	9/26/96
Unit:	PROCESS STEAM BOILER	By:	B. Fangmeier

Stack Area (ft^2):	9.271
Stack Depth (in.):	30.00
Stack Height (in.):	44.50
Equivalent Diameter (in)	35.84
Coupling Length (in.):	5.00

DISTURBANCES:	FEET	INCHES	DIAMETERS
Downstream:	0	71.375	2.0
Upstream:	0	17.625	0.5

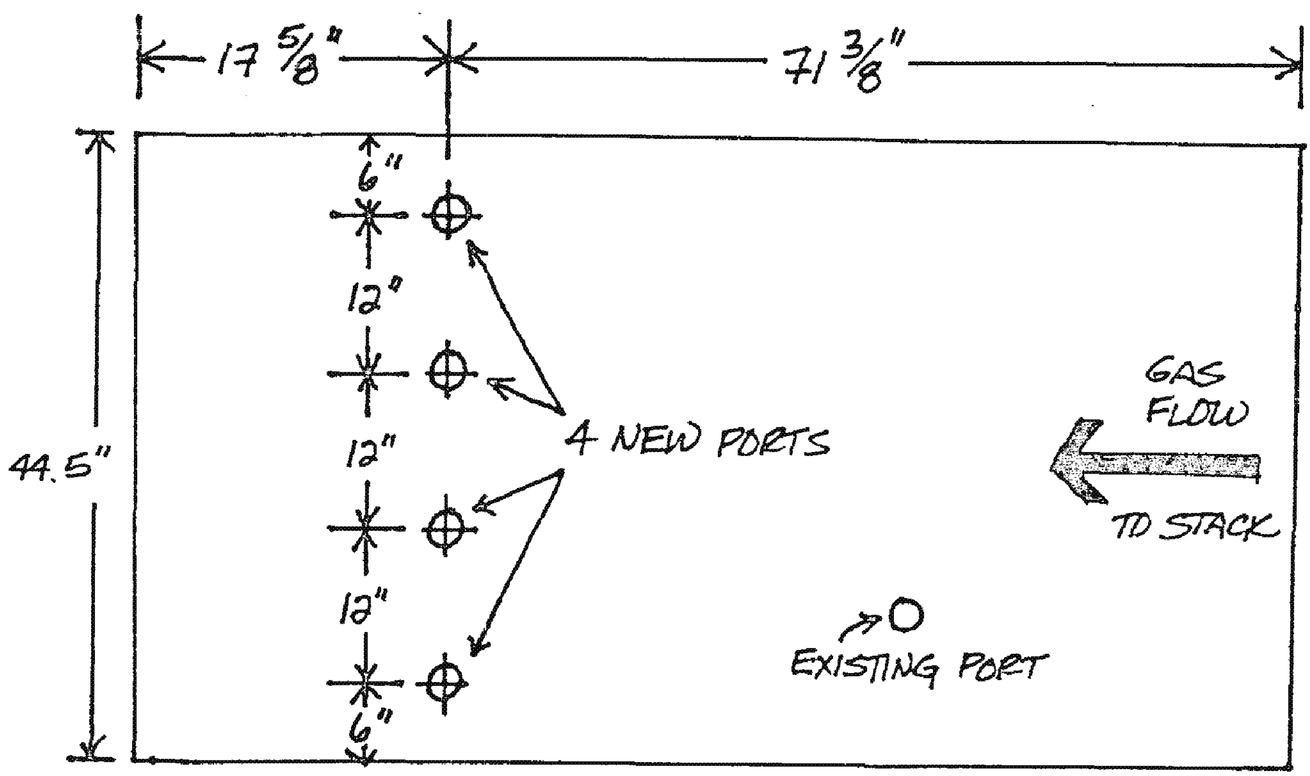
Velocity Sample Points

Point	Inches from Wall	Inches from Nozzle
1	3.75	8.75
2	11.25	16.25
3	18.75	23.75
4	26.25	31.25

CEMS Sample Points

Point	Inches from Wall	Inches from Nozzle
1	5.00	10.00
2	15.00	20.00
3	25.00	30.00

(1) From SCAQMD Method 1.1



Appendix C.2

Carnot CEMS Data

CARNOT
SCAQMD METHOD 100.1 TEST DATA

Client:	ARMSTRONG WORLD IND.	Condition:	6000 pph steam
Location:	SOUTH GATE	Date:	9/26/96
Unit:	PROCESS STEAM BOILER	Operator:	BAF
Test Number:	1-CEM	Test Location:	DUCT TO STACK

			Analyzer Values					
			O_2	CO_2	NO_x	CO	SO_2	STATUS
Analyzer Span Range			10	25	55			
Units			%	%	ppm	ppm	ppm	
Span Calibration Gas Value			5.026	14.99	22.72			
			As Found Analyzer Readings					
Zero			0.07	0.00	-0.02			
Span			5.55	14.97	22.70			
			Pre-Test System Bias					
System Bias Zero			0.05	0.03	0.05			
Zero Bias, % of Span Range			-0.2%	0.1%	0.1%			PASS
System Bias Span			5.57	14.96	22.42			
System Bias, % of Span Range			0.2%	0.0%	-0.5%			PASS
Sample	Time		Raw Test Data					
Point	Start	Stop	O_2	CO_2	NO_x	CO	SO_2	
A-3	13:00	13:05	7.24	7.76	24.23			
2	13:05	13:10	6.94	7.94	22.88			
1	13:10	13:15	6.72	8.07	22.98			
B-3	13:15	13:20	7.25	7.74	23.37			
2	13:20	13:25	6.62	8.11	23.00			
1	13:25	13:30	6.57	8.14	23.32			
C-3	13:30	13:35	6.55	8.14	22.50			
2	13:35	13:40	7.01	7.84	21.56			
1	13:40	13:45	7.36	7.69	23.49			
D-3	13:45	13:50	6.41	8.23	22.26			
2	13:50	13:55	6.45	8.19	21.95			
1	13:55	14:00	6.97	7.90	23.40			
			Post-Test System Bias					
System Bias Zero			0.03	0.03	0.02			
Zero Bias, % of Span Range			-0.4%	0.1%	0.1%			PASS
System Bias Span			5.53	14.98	22.56			
System Bias, % of Span Range			-0.2%	0.0%	-0.3%			PASS
			Drift					
Zero Drift, % of Span Range			-0.2%	0.0%	-0.1%			PASS
Span Drift, % of Span Range			-0.4%	0.1%	0.3%			PASS
			Summary of Test Results					
			O_2	CO_2	NO_x	CO	SO_2	
Raw Average			6.84	7.98	22.91			
Corrected Average			6.20	7.98	23.15			

NO_x Compliance Determination **28.19** **ppm NO_x at 3% O_2**

Appendix C.3

Fuel Meter Relative Accuracy Audit Calculations

$$F\ factor \times Fuel\ Rate \times HV \times \frac{20.9}{20.9 - O_2}$$

$$\frac{8710}{10^6} \times 101.7 \times 1050 \times \frac{20.9}{20.9 - 6.2} = 1322$$

CARNOT

RECLAIM LARGE SOURCE COMPLIANCE TESTING
FUEL METER RELATIVE ACCURACY AUDIT DATA AND WORKSHEET

Test:	RAA	
Station:	AWI	
Unit:	Process Steam Boiler	
Performed By:	BAF, RKM	
Date:	9/26/96	
Start/Stop Time:	1300-1400	
Test Condition:	6000 pph steam	
Barom. Pressure:	29.51	
Pstack:	-0.48	iwg
Pstack:	29.47	"Hg
O_2 (from Test 1-CEM):	6.20	%
CO_2 (from Test 1-CEM):	7.98	%
H_2O:	13.9	%
MW:	27.92	lb/lb-mol
Cp:	0.84	
Tref:	68	°F
Stack Area:	9.271	ft^2

METHOD 4.1 DATA

Time	Dry Gas Meter Vol.	T_m(in)	T_m(out)	Impingers #/Matl.	End	Start	Difference
0	417.928	71	71	1/H2O	782.7	681.6	101.1
		91	73	2/H2O	558.0	553.0	5.0
		101	81	3/Empty	499.3	497.6	1.7
60	453.174	106	86	4/S.G.	847.2	837.2	10.0
Total	35.246		85.0	Total			117.8

Meter Y_d:	1.0164
Meter Pressure:	1.00 iwg
Sample Volume:	34.314 dscf
H_2O Volume :	5.560 scf
Moisture Content:	13.9 %

METHOD 2.1 DATA

Point	1A-RAA dP (in. H_2O)	1A-RAA Angle (degrees)	1A-RAA Temp. °F	1B-RAA dP (in. H_2O)	1B-RAA Angle (degrees)	1B-RAA Temp. °F	1C-RAA dP (in. H_2O)	1C-RAA Angle (degrees)	1C-RAA Temp. °F
D-4	0.015	0	379	0.028	0	308	0.005	0	355
3	0.012	0	382	0.008	0	322	0.007	0	355
2	0.016	0	352	0.010	0	335	0.010	0	349
1	0.023	0	320	0.007	0	335	0.008	0	333
C-4	0.023	0	406	0.018	0	346	0.010	0	351
3	0.019	0	410	0.008	0	345	0.006	0	357
2	0.017	0	410	0.006	0	352	0.005	0	360
1	0.030	0	390	0.009	0	355	0.008	0	361
B-4	0.026	0	403	0.010	0	344	0.005	0	336
3	0.012	0	419	0.015	0	357	0.011	0	349
2	0.011	0	433	0.015	0	363	0.011	0	359
1	0.016	0	432	0.012	0	364	0.008	0	362
A-4	0.013	0	410	0.006	0	341	0.006	0	338
3	0.012	0	404	0.010	0	344	0.007	0	343
2	0.012	0	403	0.010	0	346	0.010	0	353
1	0.050	0	341	0.012	0	348	0.011	0	360
Average	0.0183	0.0	393.4	0.0110	0.0	344.1	0.0078	0.0	351.3

	1A-RAA	1B-RAA	1C-RAA
Velocity, ft/sec:	9.87	7.43	6.31
Axial Velocity, ft/sec:	9.87	7.43	6.31
Stack Flow Rate, wacfm:	5,488.2	4,134.1	3,507.9
Stack Flow Rate, dscfm:	2,878.7	2,301.4	1,935.4

FUEL METER RELATIVE ACCURACY AUDIT RESULTS

Test No.	Measured Flow (2.1 and 4.1 Data) (dscfm)	Calculated Flow (F-Factor) (dscfm)	fuel
1A-RAA	2878.7	1322.8 ✓	101.7
1B-RAA	2301.4	1372.5	105.5
1C-RAA	1935.4	1338.1	102.9
Average	2371.8	1344.4	

RELATIVE ACCURACY:

-43.3%

$$RA = \frac{\bar{C} - \bar{A}}{\bar{A}}$$

Appendix C.4

Fuel Meter Relative Accuracy Audit Velocity Data

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VELOCITY TRAVERSE DATA

CLIENT/LOCATION: ARMSTRONG WORLD IND.

SAMPLE LOCATION: DUCT TO STACK

UNIT NO.: PROCESS STEAM BOILER

TEST DESCRIPTION: RAA VEL. TRAVERSE

BARO. PRESS. (in. Hg): 29.51

DATE: 9/26/96

DATA TAKEN BY: BF / RM

PITOT TUBE COEFFICIENT(C_p): 0.84

PITOT ID NO.: 104

PITOT LEAK CHECK: ✓

TC READOUT I.D.: TC009

$$V_s = 2.90 \quad Cp \quad \sqrt{\Delta P \quad T_s} \quad \sqrt{\frac{29.92}{P_s} \quad X \quad \frac{28.95}{MW}}$$

T_s=*Stack Temp.* °F + 460

$$Avg.\Delta P = \left(\frac{\sum \sqrt{\Delta P}}{n}\right)^2$$

$$P_s = BP + \frac{Static\ (in.\ H_2O)}{13.6}$$

Test No: 1A-RAA — Static Pressure (in. H_2O): -0.48

TIME	TRAVERSE POINT PORT	TRAVERSE POINT POINT	VELOCITY HEAD in. H_2O, ΔP	GAS TEMP °F
1305	D	4	0.015	379
		3	0.012	382
		2	0.016	352
		1	0.023	320
	C	4	0.023	406
		3	0.019	410
		2	0.017	410
		1	0.030	340
	B	4	0.026	403
		3	0.012	419
		2	0.011	433
		1	0.016	432
	A	4	0.013	410
		3	0.012	404
		2	0.012	403
1316		1	0.050	341
Avg.			0.0183	393.4

Test No: 1B-RAA — Static Pressure (in. H_2O): -0.48

TIME	TRAVERSE POINT PORT	TRAVERSE POINT POINT	VELOCITY HEAD in. H_2O, ΔP	GAS TEMP °F
1321	D	4	0.028	308
		3	~~0.012~~ ~~0.030~~ 0.008	~~313~~ 322
		2	0.010	335
		1	0.007	335
	C	4	0.018	346
		3	0.008	345
		2	0.006	352
		1	0.009	355
	B	4	0.010	344
		3	0.015	357
		2	0.015	363
		1	0.012	364
	A	4	0.006	341
		3	0.010	344
		2	0.010	346
1331		1	0.012	348
Avg.			0.0110	344.1

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CARNOT
VELOCITY TRAVERSE DATA

CLIENT/LOCATION: ARMSTRONG WORLD IND.
DATE: 9/26/96
SAMPLE LOCATION: DUCT TO STACK
DATA TAKEN BY: BAF / BM
UNIT NO.: PROCESS STEAM BOILER
PITOT TUBE COEFFICIENT (C_p): 0.84
TEST DESCRIPTION: RAA VELOCITY TRAVERSE
PITOT ID NO.: 104
BARO. PRESS. (in. Hg): 29.51
PITOT LEAK CHECK: ✓
TC READOUT I.D.: TC079

$$V_s = 2.90 \quad Cp \quad \sqrt{\Delta P \quad T_s} \quad \sqrt{\frac{29.92}{P_s} \quad X \quad \frac{28.95}{MW}}$$

T_s=Stack Temp. °F + 460

$$Avg.\Delta P = \left(\frac{\sum \sqrt{\Delta P}}{n}\right)^2$$

$$P_s = BP + \frac{\text{Static (in. } H_2O)}{13.6}$$

Test No: 1C-RAA | Static Pressure (in. H_2O): -0.48

TIME	TRAVERSE POINT PORT	POINT	VELOCITY HEAD in. H_2O, ΔP	GAS TEMP °F
1341	D	4	0.605	355
		3	0.007	355
		2	0.010	349
	C	1	0.008	333
		4	0.010	351
		3	0.006	357
		2	0.005	360
		1	0.008	361
	B	4	0.005	336
		3	0.011	349
		2	0.011	359
		1	0.008	362
	A	4	0.006	338
		3	0.007	343
		2	0.010	353
1353		1	0.011	360
Avg.			0.0078	351.3

Test No: | Static Pressure (in. H_2O):

TIME	TRAVERSE POINT PORT	POINT	VELOCITY HEAD in. H_2O, ΔP	GAS TEMP °F
Avg.				

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Appendix C.5

Fuel Meter Relative Accuracy Audit Moisture Data

CARNOT SAMPLE TRAIN TEST DATA

CLIENT ARMSTRONG WORLD IND. UNIT BOILER TEST NO. 1-H_2O METHOD SCAQMD 4.1 PAGE 1 OF 1

SAMPLE LOCATION DUCT TO STACK TEST CONDITION 6000 pph steam AMB. TEMP., °F ______ PROJECT # 11593

OPERATOR/ASSISTANT BF / RM METER VOL. (START/END) 417.928 / 453.174 DATE 9/26/96

PRE-TEST DATA:

Barometric Press., in. Hg.	29.51
Assumed Stack Temp. °F	
Assumed Meter Temp. °F	
Assumed ΔP	
Assumed Moisture %	
Stack Diameter, in.	
Sample Time: Total	60 min
per point	60 min
Total of Traverse Points	SINGLE POINT
Teflon Connecting Line (Y/N)	Y.
Isokinetic Factor	

ΔH = 1.0 X ~~ΔP~~

EQUIPMENT INFO:

Meter ID No.		ES-19
Meter, Yd.		1.0164
CFM @ ΔH = 1.0		0.596
Pitot:	ID	
	Cp	
Probe:	Mat'l	SS
	Length	3'
Nozzle:	ID/Mat'l	
	Diam.	
Filter:	No.	
	Tare Wt.	
TC Readout ID:	Meter	TC 009
	Aux.	

Imp.	Mat'l	Wt.(End)	-	Wt.(Start)	=	Wt.(g)
#1	H_2O	782.7	-	681.6	=	101.1
#2	H_2O	558.0	-	553.0	=	5.0
#3	Ø	499.3 ~~[illegible]~~	-	497.6	=	1.7
#4	S.G.	847.2	-	837.2	=	10.0
#5			-		=	
Total					=	117.8

POST TEST INFO:

Filter Appearance	—
Impinger Appearance	CLEAR
Silica Gel Spent (Y/N)	N

SAMPLE TRAIN LEAK CHECK:

	CFM	Vac	Pitot	Init
Pre-Test	0.003	11"	—	BAF
Post-Test	0.001	7"	—	BAF

PRE-TEST CALIBRATION CHECK:

	Time	ΔH	Meter Reading	Meter In	Temp Out
Init					
Final					

SAMPLE POINT	TIME	METER CONDITIONS ΔP	ΔH	METER READING	TEMPERATURES, °F STACK	PROBE	METER IN	METER OUT	OVEN	IMP. OUT	O_2	VAC.	STATIC PRESS. Iwg
SINGLE	1300		1.0	417.928			71	71		ICE		2	
POINT	1245		↓	426.2			91	73		48		2	
	1300			435.2			101	81		50		2	
	1315			444.1			106	86		53		2	
END	1400			453.174			~~[illegible]~~						

CHAIN OF CUSTODY INFORMATION

Impingers Loaded	BAF
Impingers Recovered	BAF
Filter Loaded	—
Filter Recovered	—
Probe Wash	—

TEST SUMMARY

Calculated by:	BAF
Checked by:	BAF
Stack Press.(iwg)	—
Stack Temp. (°F)	—
ΔP (iwg)	—
O_2/CO_2	—
Meter Vol., (acf)	35.246 ✓
Meter Temp. (°F)	85.0 ✓
Meter Press. (iwg)	1.0 ✓
Liquid Vol. (g)	117.8 ✓

Comments

APPENDIX D
ARMSTRONG PROCESS STEAM BOILER DATA

Appendix D.1

Fuel Flow Measurements for Fuel Meter Relative Accuracy Audit

RELATIVE ACCURACY AUDIT FUEL FLOW MEASUREMENTS
RECLAIM LARGE SOURCE COMPLIANCE TESTING
PROCESS STEAM BOILER
ARMSTRONG WORLD INDUSTRIES, INC.
SOUTH GATE PLANT
SEPTEMBER 26, 1996

1A-RAA

Time of Reading (hr:min)	Fuel Volume (acf)	Time (sec)	Time (min)	Fuel Flow (acfm)	Correction Factors (Temperature)	Correction Factors (Pressure)	Fuel Flow (scfm)
13:00	100	73.9	1.23	81.2	0.99	1.26	101.3
13:10	100	72.4	1.21	82.9	0.99	1.26	103.4
13:20	100	74.5	1.24	80.5	0.99	1.26	100.5
					AVERAGE FUEL FLOW FOR RAA TEST, SCFM:		101.7

1B-RAA

Time of Reading (hr:min)	Fuel Volume (acf)	Time (sec)	Time (min)	Fuel Flow (acfm)	Correction Factors (Temperature)	Correction Factors (Pressure)	Fuel Flow (scfm)
13:20	100	74.5	1.24	80.5	0.99	1.26	100.5
13:30	100	65.4	1.09	91.7	0.99	1.26	114.4
13:40	100	73.6	1.23	81.5	0.99	1.26	101.7
					AVERAGE FUEL FLOW FOR RAA TEST, SCFM:		105.5

1C-RAA

Time of Reading (hr:min)	Fuel Volume (acf)	Time (sec)	Time (min)	Fuel Flow (acfm)	Correction Factors (Temperature)	Correction Factors (Pressure)	Fuel Flow (scfm)
13:40	100	73.6	1.23	81.5	0.99	1.26	101.7
13:50	100	65.4	1.09	91.7	0.99	1.26	114.4
14:00	100	80.9	1.35	74.2	0.99	1.26	92.5
					AVERAGE FUEL FLOW FOR RAA TEST, SCFM:		102.9

FUEL FLOW MEASUREMENTS
PROCESS STEAM BOILER
ARMSTRONG WORLD INDUSTRIES

9/26/96

TIME (hr:min)	TIMED VOLUME (acf)	TIME (min:sec)	TIME (SEC)
12:25	200	1:27.8	
13:00	~~200~~ 100	1:13.9	73.9
13:10	100	1:12.4	72.4
13:20	100	1:14.5	74.5
13:30	100	1:05.4	65.4
13:40	100	1:13.6	73.6
13:50	100	1:05.4	65.4
14:00	100	1:20.9	80.9

PRESSURE AND TEMPURATURE CORRECTION FACTORS

AMERICAN METER CO. MODEL 3GT-10M

PROCESS STEAM BOILER

ARMSTRONG WORLD INDUSTRIES

SOUTH GATE PLANT

Used for Emission Calculatio n

Begin Read	294358	######	
End Read	296458	######	
Uncorrected Amount	2100	mcf	- Heat Input -
Amount Calculated	2.61954	mmcf	2,750.52 mmBTU
Pressure	3.90	psig	
Pressure Factor	1.26		
Temperature	64.40	degree F	
Temperature Factor	0.99		
High Heat Value	1050.00	mmBTU/mmcf	
Emission Factor	38.28	lbs/mmcf	
Emission Amount	100.28	lbs	

OK

Cancel

Calculate

Reset

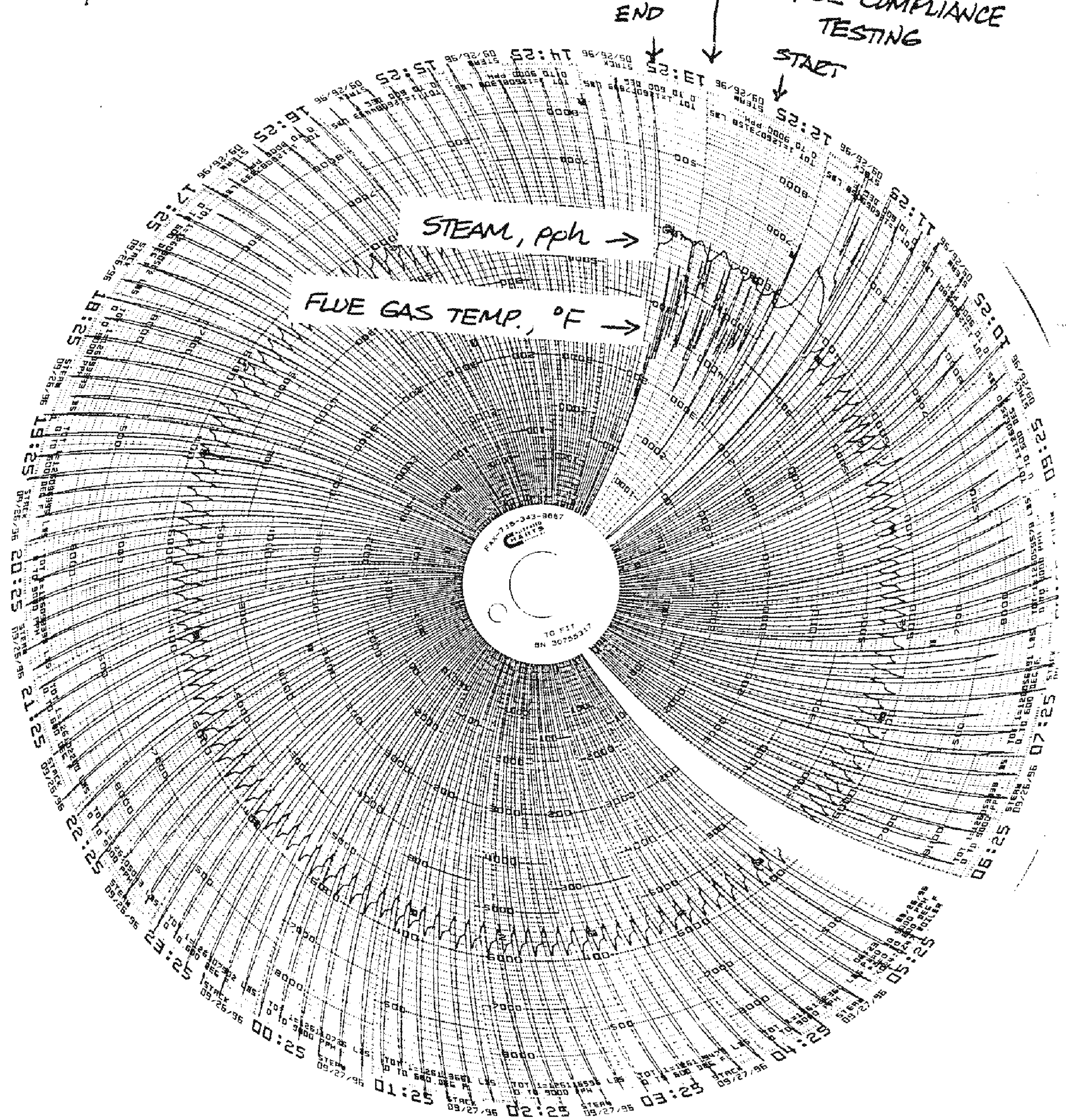
Appendix D.2

Boiler Circle Chart and Boiler Log

ARMSTRONG WORLD INDUSTRIES

PROCESS STEAM BOILER

9/26/96



NOTE: CIRCLE CHART TIME = ONE HOUR BEHIND ACTUAL TIME

South Gate, CA

Date: 9-26-96

DAILY BOILER LOG

Time	Water Leve.	Steam Press.	Manual Blow	Initials
11 pm	OK	121		S.
12 mid	OK	120		S.
1 am	OK	123		S.
2 am	OK	125		S.
3 am	OK	121		S.
4 am	OK	119		S.
5 am	OK	120		S.
6 am	OK	123		S.
7 am	OK	125		BM
8 am	OK	124		BM
9 am	OK	120		BM
10 am	OK	122		BM
11 am	OK	118		BM
Noon	OK	123		BM
1 pm	OK	120		BM
2 pm	OK	125		BM
3 pm	OK	122		JH
4 pm	OK	125		JH
5 pm	OK	118		JH
6 pm	OK	123		JH
7pm	OK	121		JH
8pm	OK	125		JH
9pm	OK	119		JH
10pm	OK	124		JH

GAS ______

FEED WATER 165252

CHEMICAL TREATMENT OF BOILER

National Chemicals

AMOUNT		INITIA.
~~1/4 F~~	D - 169	BM
~~1/4 F~~	D - 087	BM
~~1/4 F~~	D - 190	BM

Continuous Blowdown Setting 3500 BM

WATER SOFTENER

Regenerate 1&2 BM

WATER LEVEL ALARMS

Time Init.

Checked at: Daily BM

Issued By: ______

Comments: ______

NOTE: Any evidence of faulty o[r] ... of any piece of equipment must [be] investigated. If you can not [fix] immediately notify your superv[isor] ... it can be taken care of. Write [on] back of this sheet any such con[ditions]

APPENDIX E
EMISSION CALCULATIONS

EMISSION CALCULATIONS

1. <u>Sample Volume and Isokinetics</u>

a. Sample gas volume, dscf

$$V_{m\ std} = 0.03342\ V_m \left(P_{bar} + \frac{H}{13.6}\right)\left(\frac{T_{ref}}{T_m}\right)(Y)$$

b. Water vapor volume, scf

$$V_{w\ std} = 0.0472\ V_{lc} \left(\frac{T_{ref}}{528\ ^\circ R}\right)$$

c. Moisture content, nondimensional

$$B_{wo} = \frac{V_{w\ std}}{V_{m\ std} + V_{w\ std}}$$

d. Stack gas molecular weight, lb/lb mole

$$MW_{dry} = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2)$$

$$MW_{wet} = MW_{dry}\ (1 - B_{wo}) + 18\ (B_{wo})$$

e. Absolute stack pressure, in Hg

$$P_s = P_{bar} + \frac{P_{sg}}{13.6}$$

f. Stack velocity, ft/sec

$$V_s = 2.90\ C_p \sqrt{\Delta P T_s} \sqrt{\left(\frac{29.92}{P_s}\right)\left(\frac{28.95}{MW_{wet}}\right)}$$

g. Actual stack flow rate, wacfm

$$Q = (V_s)(A_s)(60)$$

h. Standard stack gas flow rate, dscfm

$$Q_{sd} = Q\ (1 - B_{wo})\left(\frac{T_{ref}}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

i. Percent isokinetic

$$I = \left(\frac{17.32\,(T_s)(V_{m\ std})}{(1 - B_{wo})(\Theta)(V_s)(P_s)(D_n^2)}\right)\left(\frac{528\ ^\circ R}{T_{ref}}\right)$$

2. Particulate Emissions

a. Grain loading, gr/dscf

$$C = 0.01543 \left(\frac{M_n}{V_{m\ std}}\right)$$

b. Grain loading at 12% CO_2, gr/dscf

$$C_{12\% CO_2} = C \left(\frac{12}{\% CO_2}\right)$$

c. Mass emissions, lb/hr

$$M = C(Q_{sd}) \frac{(60\ min/hr)}{(7000\ gr/lb)}$$

3. Gaseous Emissions, lb/hr

$$M = (ppm)(10^{-6})\left(\frac{MW_i\ lb/lb\ mole}{SV}\right)(Q_{sd})(60\ min/hr)$$

where,

SV = *specific molar volume of an ideal gas:*

$$SV = 385.3\ ft^3/lb\ mole \quad for\ T_{ref} = 528\ °R$$

$$SV = 379.5\ ft^3/lb\ mole \quad for\ T_{ref} = 520\ °R$$

4. Emissions Rates, lb/10^6 Btu

a. Fuel factor at 68 °F, dscf/10^6 Btu at 0% O_2

$$F_{68} = \frac{10^6[3.64(\%H) + 1.53(\%C) + 0.14(\%N) + 0.57(\%S) - 0.46(\%O_2 fuel)]}{HHV,\ Btu/lb}$$

b. Fuel factor at 60 °F

$$F_{60} = F_{68}\left(\frac{520\ °R}{528\ °R}\right)$$

c. Gaseous Emissions factor

$$\left(\frac{lb}{10^6\ Btu}\right)_i = (ppm)_i\ (10^{-6})\left(\frac{MW_i\ lb}{lb\ mole}\right)\left(\frac{1}{SV}\right)(F)\left(\frac{20.9}{20.9 - \%O_2}\right)$$

d. Paticulate emission factor

$$\left(\frac{lb}{10^6\ Btu}\right) = C\left(\frac{1\ lb}{7000\ gr}\right)(F)\left(\frac{20.9}{20.9\ -\ \%O_2}\right)$$

Nomenclature:

A_s = stack area, ft^2

B_{wo} = flue gas moisture content

$C_{12\%\ CO_2}$ = particulate grain loading, gr/dscf corrected to 12% CO_2

C = particulate grain loading, gr/dscf

C_p = pitot calibration factor, dimensionless

Dn = nozzle diameter, in.

F = fuel F factor, dscf/10^6 Btu at 0% O_2

H = orifice pressure differential, iwg

I = % isokinetics

M_n = mass of collected particulate, mg

M_i = mass emissions of species i, lb/hr

MW = molecular weight of flue gas

MW_i = molecular weight of species i:

NO_x	:	46
CO	:	28
SO_x	:	64
HC	:	16

Nomenclature (Continued):

θ	=	sample time, min.
ΔP	=	average velocity head, iwg = $\left(\overline{\sqrt{\Delta P}}\right)^2$
P_{bar}	=	barometric pressure, in.Hg
P_s	=	stack absolute pressure, in.Hg
P_{sg}	=	stack static pressure, iwg
Q	=	wet stack gas flow rate at actual conditions, wacfm
Qsd	=	dry stack gas flow rate at standard conditions, dscfm
SV	=	specific molar volume of an ideal gas at standard conditions, ft^3/lb mole
Tm	=	meter temperature, °R
T_{ref}	=	reference temperature, °R
Ts	=	stack temperature, °R
V_s	=	stack velocity, ft/sec
V_{lc}	=	volume of liquid collected in impingers, ml
Vm	=	dry meter volume uncorrected, dcf
$V_{m\ std}$	=	dry meter volume at standard conditions, dscf
$V_{w\ std}$	=	volume of water vapor at standard conditions, scf
Y	=	meter calibration coefficient

APPENDIX F

CARNOT CEMS STRIP CHART

FIRING" M
OF OPERA

O2avg1 INTVL 1 7.18% CO2avg1 Sep.26 12:26 4.51% NOxavg1 11.19ppm 5.00 10.00 15.00 20.00 25.00

← MAIN BURNER ON

O2avg1 INTVL 1 8.70% CO2avg1 Sep.26 12:20 6.98% NOxavg1 20.90ppm

← MAIN BURNER OFF

O2avg1 INTVL 1 8.86% CO2avg1 Sep.26 12:16 2.99% NOxavg1 9.67ppm

← MAIN BURNER ON

O2avg1 INTVL 1 9.02% CO2avg1 Sep.26 12:10 6.72% NOxavg1

← MAIN BURNER OFF

BOILER OPERATI
WITH MAIN
BURNER C
ON AND OF

O2avg1 INTVL 1 7.78% CO2avg1 Sep.26 12:06 4.02% NOxavg1 9.70ppm

200mm/h 12:06

O2avg1 INTVL 1 5.28% CO2avg1 Sep.26 12:00 3.88% NOxavg1 6.24ppm 5.00 10.00 15.00 20.00 25.00 ppm

300mm/h Sep.26 12:00

MANUAL Sep.26.96 11:58
O2 0.06% CO2 0.01% NOx 10.80ppm O2dvg1 4.06%
CO2avg1 6.02% NOxavg1 5.36ppm

SYSTEM
AND ZER

0 10 20 30 40 50 60 70 80 90 100

MANUAL Sep.26.96 11:57
O2 5.60% CO2 14.99% NOx 0.01ppm O2dvg1 6.17%
CO2avg1 6.25% NOxavg1 5.60ppm

MANUAL Sep.26.96 11:55
O2 ******% CO2 0.13% NOx 11.05ppm O2dvg1 ******
CO2avg1 0.10% NOxavg1 11.03ppm

NOx MID
AS FOUND

O2avg1 INTVL 1 ******% CO2avg1 Sep.26 11:55 0.10% NOxavg1 16.43ppm 10.00 15.00 20.00 25.00 ppm

MANUAL Sep.26.96 11:53
O2 ******% CO2 0.10% NOx 22.62ppm O2dvg1 ******
CO2avg1 4.09% NOxavg1 17.97ppm

NOx HIGH
SPAN SE

.00 5.00 10.00 15.00 20.00 25.00

O2avg1 INTVL 1 ******% CO2avg1 Sep.26 11:50 11.38% NOxavg1 22.13ppm

MANUAL Sep.26.96 11:49
O2 ******% CO2 0.11% NOx 22.78ppm O2dvg1 ******
CO2avg1 12.19% NOxavg1 22.65ppm

MANUAL Sep.26.96 11:48
O2 ******% CO2 14.97% NOx 22.61ppm O2dvg1 ******
CO2avg1 4.89% NOxavg1 22.64ppm

CO_2 MID S
AS FOUN

O2avg1 INTVL 1 6.51% CO2avg1 Sep.26 11:45 16.24% NOxavg1 18.39ppm

0.00 2.00 4.00 6.00 8.00 10.00

2

0 10 20 30 40 50 60 70 80 90 100

MANUAL Sep.26.96 11:42
O2 5.55% CO2 14.00% NOx 22.23ppm O2dvg1 8.56%
CO2avg1 16.07% NOxavg1 14.05ppm

O_2 MID SP
AS FOUN

0.00 2.00 4.00 6.00 8.00 10.00

MANUAL Sep.26.96 11:40
O2 9.02% CO2 22.38% NOx 0.01ppm O2dvg1 9.03%
CO2avg1 22.38% NOxavg1 0.01ppm

O_2/CO_2 HIGH
SET
NO_x ZERO

INTVL 1 Sep.26 11:40 0.00 2.00 4.00 6.00 8.00 10.00

NO_x: 0-25ppm

MANUAL Sep.26.96 11:37
O2 0.07% CO2 0.00% NOx 0.21ppm O2dvg1 0.77%
CO2avg1 0.09% NOxavg1 0.33ppm

O_2/CO_2 ZE
SET

O_2: 0-10 ppm

CO_2: 0-25 ppm

11:20 11:36 300mm/h

2

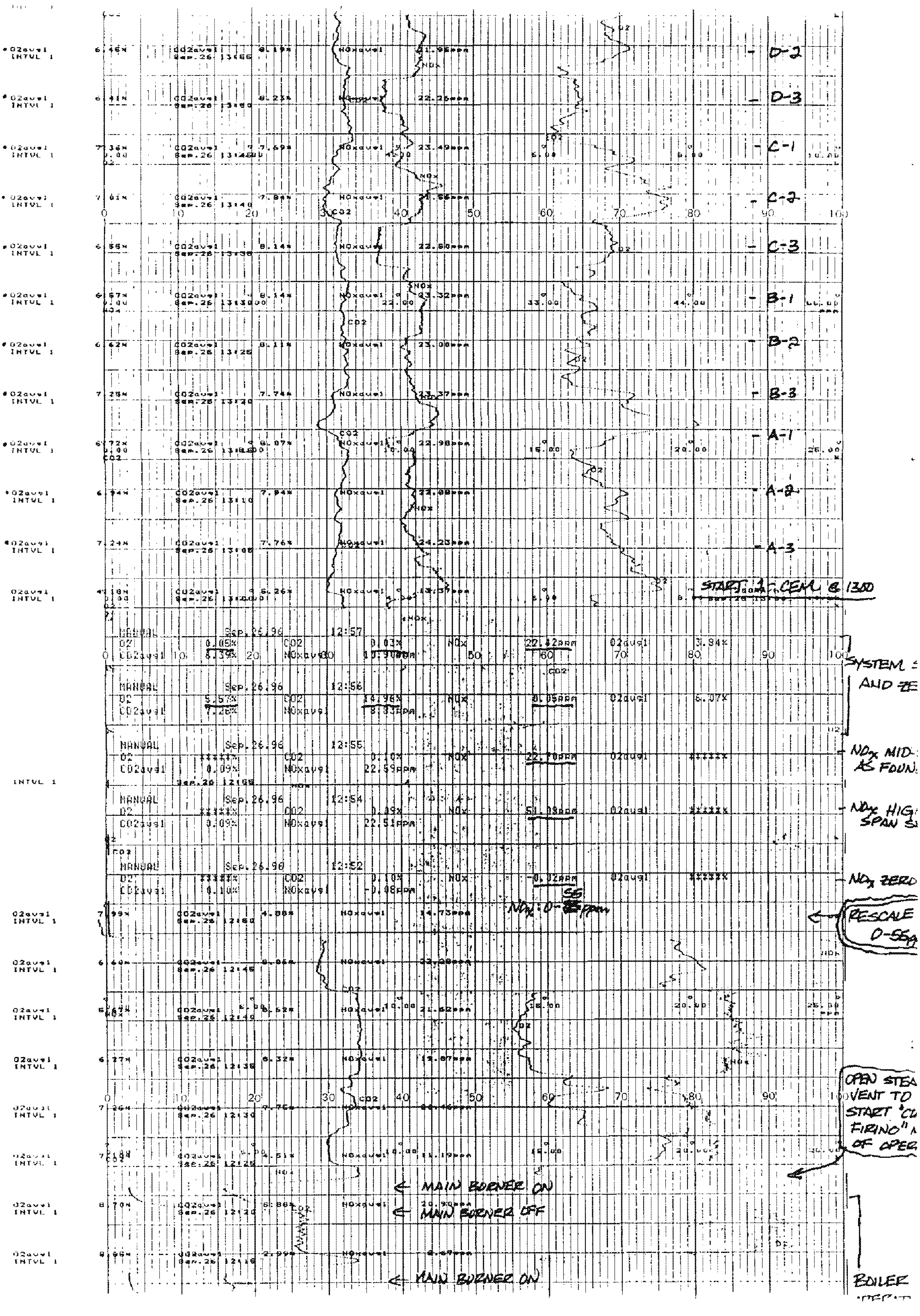
ARMSTRONG WORLD INDUSTRIES, INC. / PROCESS STEAM BOILER 11-523

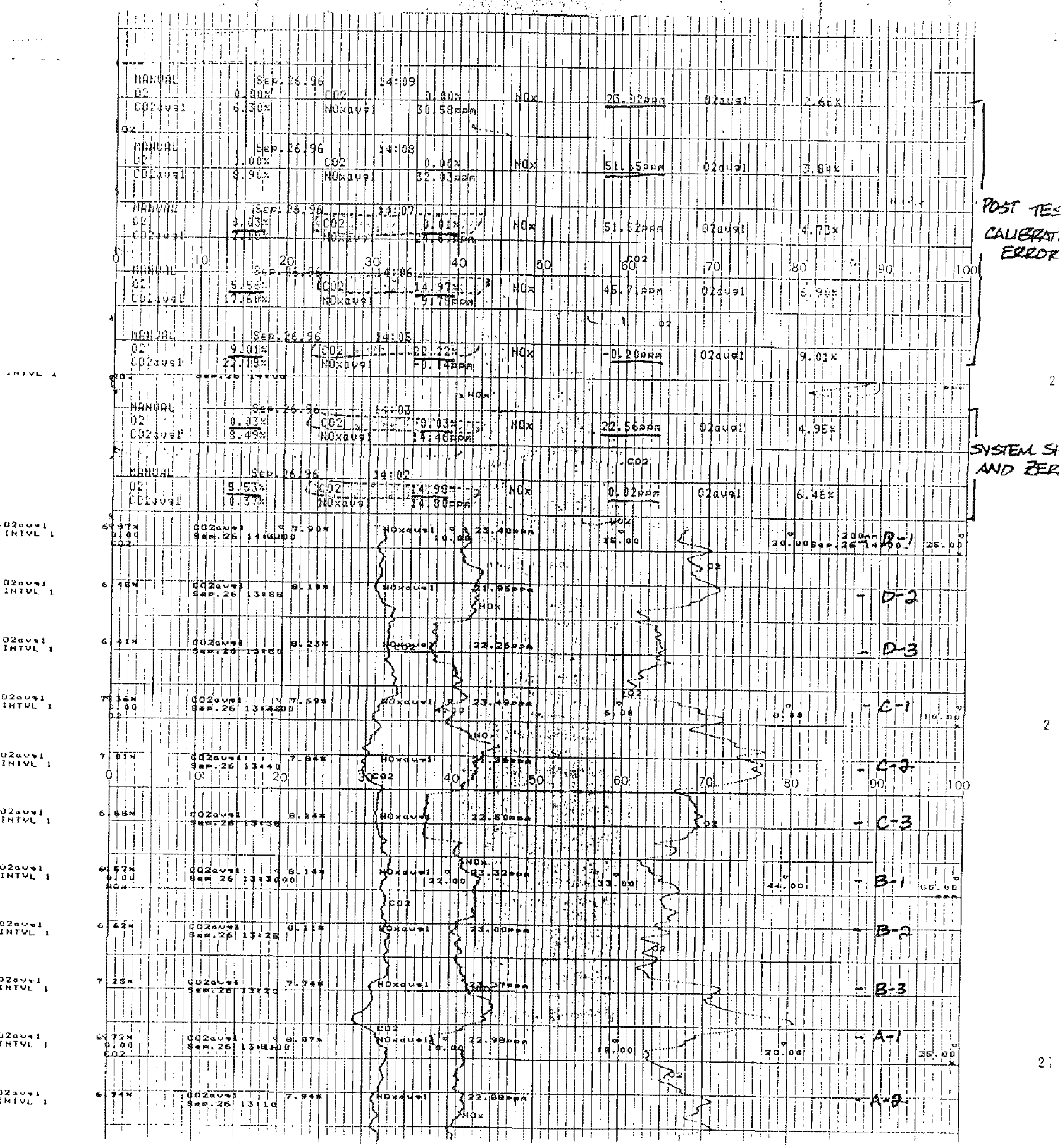
RECLAIM LARGE SOURCE COMPLIANCE

9/26/96

CARNOT: Faungmeier, Rick Madrigal

ARMSTRONG: Bill Woyshner


D-2
D-3
C-1
C-2
C-3
B-1
B-2
B-3
A-1
A-2
A-3
START 3-CEM @ 1300
MANUAL Sep.26.96 12:57
O2 0.05% CO2 0.03% NOx 22.42ppm O2avg1 3.94%
CO2avg1 6.39% NOxavg1 10.90ppm
SYSTEM S
AND ZE
MANUAL Sep.26.96 12:56
O2 5.57% CO2 14.98% NOx 0.05ppm O2avg1 6.07%
CO2avg1 7.26% NOxavg1 8.33ppm
MANUAL Sep.26.96 12:55
CO2 0.10% NOx 22.70ppm
CO2avg1 0.09% NOxavg1 22.59ppm
NOx MID
AS FOUN
MANUAL Sep.26.96 12:54
CO2 0.09% NOx 51.09ppm
CO2avg1 0.09% NOxavg1 22.51ppm
NOx HIG
SPAN S
MANUAL Sep.26.96 12:52
CO2 0.10% NOx -0.02ppm
CO2avg1 0.10% NOxavg1 -0.08ppm
NOx ZERO
NOx: 0-55 ppm
RESCALE
0-55
OPEN STEA
VENT TO
START "C
FIRING"
OF OPER
MAIN BURNER ON
MAIN BURNER OFF
MAIN BURNER ON
BOILER



MANUAL Sep.26.96 14:09
O2 0.00% CO2 0.00% NOx 20.02ppm O2avgl 2.66%
CO2avgl 6.30% NOxavgl 30.59ppm
MANUAL Sep.26.96 14:08
O2 0.00% CO2 0.00% NOx 51.65ppm O2avgl 3.84%
CO2avgl 3.90% NOxavgl 32.03ppm
MANUAL Sep.26.96 14:07
O2 0.03% CO2 0.01% NOx 51.52ppm O2avgl 4.70%
MANUAL Sep.26.96 14:06
O2 5.56% CO2 14.97% NOx 45.71ppm O2avgl 6.90%
CO2avgl 17.80% NOxavgl 9.79ppm
MANUAL Sep.26.96 14:05
O2 9.01% CO2 22.22% NOx -0.20ppm O2avgl 9.01%
CO2avgl 22.19% NOxavgl -0.14ppm
MANUAL Sep.26.96 14:03
O2 0.03% CO2 0.03% NOx 22.56ppm O2avgl 4.95%
CO2avgl 3.49% NOxavgl 14.46ppm
MANUAL Sep.26.96 14:02
O2 5.53% CO2 14.99% NOx 0.02ppm O2avgl 6.45%
CO2avgl 10.37% NOxavgl 14.80ppm
0 10 20 30 40 50 60 70 80 90 100
POST TES
CALIBRAT.
ERROR
SYSTEM S
AND ZER
O2avgl INTVL 1
CO2avgl
NOxavgl
D-1
D-2
D-3
C-1
C-2
C-3
B-1
B-2
B-3
A-1
A-2

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

MEMORANDUM

DATE: November 5, 1996

TO: John Higuchi

FROM: Merrill Hickman MKH

SUBJECT: Review Request

ASTD RECEIVED
NOV 05 1996
S.T. & E. BRANCH

The attached document is submitted for your evaluation. We would appreciate it if your staff could review and provide comments or approval by the indicated date. Thank you.

REQUESTED RESPONSE DATE: December 5, 1996 **A/N** N/A

COMPANY NAME & LOCATION: Armstrong World Industries - ID# 012155

PROJECT DESCRIPTION: Source testing to show compliance with Rule 2012 (j)(2). Test duration per device is 60 minutes-minimum, 1 run-minimum, load is at the facility's choice. Three run RAA.
Device D156 - Boiler

CONTACT & RETURN TO: Merrill Hickman Ext. 2676

DOCUMENT ATTACHED FOR REVIEW: [X] RECLAIM

S/T	[ ]	CEM
S/T & LAB	[ ]	Test Protocol
S/T & LAB	[X]	Test Report
		[X] test protocol already approved
		[ ] test protocol not approved
S/T & LAB	[ ]	Other:

NOTES: Please review the attached protocol for proper test methods and procedures.

APPLIED SCIENCE & TECHNOLOGY
SOURCE TESTING & ENGINEERING

CHECKLIST FOR REQUEST TO REVIEW SOURCE TEST PROTOCOL/REPORT(ST-1)

Submit this checklist with the review request memorandum when an evaluation of a source test protocol or report is requested.

The reviewing engineer will use this checklist to assure that basic information necessary to do the evaluation is either provided in the report or included with the request. An incomplete submittal will delay the evaluation of the report.

LIST I Check off each of the following items to verify that the information is provided in the source test report/protocol and then send it along with the report/protocol.

[✓] Information form ST-2 with those applicable parts filled out completely.

[✓] **Complete** Permit to Construct or Permit to Operate, including all conditions. (facility permit not included due to size per discusion with Steve Marinoff, if it becomes necesary please contact Merrill at x2676)

[✓] Brief description of the equipment (to be) tested.

[✓] Brief process description, including maximum and normal operating temperatures, pressures, through-put, etc.

[✓] Operating conditions under which test (will be) was performed.

[✓] Process schematic diagram showing the ports and sampling locations, including the dimensions of the ducts/stacks at the sampling locations, along with upstream and downstream distances to flow disturbances, (e.g. elbows, tees, fans) from the sampling locations.

[✓] Field and laboratory data forms.

[✓] Brief description of sampling and analytical methods for each constituent to be measured. If a standard District, EPA, or ARB method without "any deviation" will be used, reference it by number.

[✓] Calculations for volumetric flow rates and emission rates.

[✓] Calibration and quality assurance procedures identified.

[✓] An acceptable method for determining usage rate of organic materials for Reg. 11 VOC testing.

[✓] Testing laboratory qualifies as an "independent testing laboratory" under Rule 304 (no conflict of interest).

APPLIED SCIENCE AND TECHNOLOGY
SOURCE TESTING & ENGINEERING

INFORMATION REQUEST FORM (ST-2) FOR PROTOCOL/REPORT REVIEW

The person requesting evaluation of a source test protocol or report shall mark the appropriate items and provide the requested information. The sampling and analytical methods will be reviewed *only* for those constituents identified on this form.

Constituent to be measured	Allowable Limits[1] concentration ppm	mass flow rate lb/hr	Rule or Permit Condition	NSPS 40CFR60 (identify subpart)	Sampling Location	Other Requriements
☑ NO_X as NO_2 D156 O_2 RAA	30		Rule 2012(j)		Exhaust Stack	3% O_2

(1) If allowable limit is specified in rule or permit by mass flow rate only, please convert to approximate ppm levels and mark with an asterisk (*).

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

APPLIED SCIENCE and TECHNOLOGY * SOURCE TESTING and ENGINEERING BRANCH

PERFORMANCE TEST PLAN EVALUATION WORKSHEET

SOURCE TEST ID #:	96082	COMPANY ID #:	012155

COMPANY: Armstrong World Industries

MAILING ADDRESS: 5037 Patata Street

MAILING CITY / ZIP: South Gate, CA 90280

BASIC EQUIPMENT: Boiler

EQUIPMENT ADDRESS: 5037 Patata St., South Gate

PERFORMANCE TEST EVALUATION *

TRXN TYPE	TYPE OF EVALUATION	HOURLY FEE	NO. OF HOURS	SUBTOTAL
36	MINIMUM FEE			$409.60
	REPORT		5	
	BASIC WORK HOURS		10	
	ADDITIONAL CHARGE IN EXCESS OF THE BASIC HOURS (15 HOURS MAX.)	$76.81	0	$0.00

TOTAL:	$409.60

($1561.80 Max.)

AUTHORIZED FOR BILLING [signature] **DATE** 2-5-96

* A minimum fee of $404.80 will be charged for the evaluation of source test protocols and reports. Additional fees will be assessed at a rate of $75.90 per hour for time spent for evaluation in excess of 10 hours up to a maximum total fee of $1543.30.